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MR. I. LOWTHIAN BELL.

MR. I. LOWTHIAN BELL AND METALLURGICAL PROGRESS.

THE wonderful rapidity with which the iron and coal resources of the United Kingdom have been developed, is a constant theme of remark, not only in our own country, but throughout the civilized world. Although one of the oldest nations in Europe, England has been able in the race of industrial supremacy not only to keep pace with, but to outrun the newest and most richly-endowed countries, whether of the Old or the New World. Within the last half-century we have made considerably more progress than in all our previous history. Demands have been made upon our limited resources by countries that have had equally good resources of their own, simply because we possessed the capital, the industry, and the capacity to which they were more or less strangers; and in spite of the more earnest and formidable competition with which England has of late years been threatened, she still retains the pre-eminent distinction of being the "workshop of the world."

Although it is undoubtedly a fact that this singular progress could not have been attained but for the conjunction of splendid natural resources with huge wealth and indomitable industry, yet it is none the less a fact that it has been largely aided and stimulated by the scientific research, and the facilities thereby provided for making the most of our resources, for which we are indebted to such men as Mr. I. L. Bell. That gentleman may now be said to stand at the head of the iron-making profession. His researches have been to the iron trade what the works of Shakespeare have been in the literature of England, "not of an age, but for all time;" and although his name has not been specially identified with any great invention destined to revolutionize the whole industrial world, or to turn into new channels the course of civilization, he has been enabled, by a long life of experiment and investigation, to methodize the metallurgy of iron; if not actually to give it a place among the exact sciences, at any rate to give it a much more exact and definite character than it ever had before; to show where further economies were possible; and to prove the nett value of many inventions and processes, respecting which there had previously been much groping and uncertainty. Added to all this, Mr. Bell has proved his claim to be esteemed one of the most advanced and intelligent metallurgical chemists of this or any other country, while in all statistical, topographical, and historical phases of the iron trade, he is perhaps the greatest living authority.

The father of Mr. Bell was a partner in the well-known firm of Losh, Wilson, and Bell, of the Walker Ironworks, on the Tyne. After completing his curriculum of study in Edinburgh and Paris, the young man was sent to learn the business of iron-making at Walker, where he continued until the year 1850. The Walker Works are among the oldest of their kind in the north of England. They were originally commenced in 1809, and until about 1829 they were carried on as engineering works and iron foundries. For many years the Walker Works were largely engaged in the manufacture of Losh's patent wheels, the invention of Mr. Losh, the senior partner of the firm, and one which had greatly tended to promote the efficiency of rolling stock. It is well to observe that the blast furnace built at Walker in 1842, was the first specially erected for smelting the lias ironstone of Cleveland, which was then raised from mines near Whitby, carried on by Mr. Clark, but which it was then considered impossible to make use of successfully without a large admixture of other and richer ores. Since that time one more furnace has been built at Walker for smelting the Whitby stone, and three more for smelting the ironstone found in the north of Cleveland. All these furnaces, however, have since been demolished or altered, owing chiefly to their distance from the sources whence the raw materials have been derived, and in their stead two furnaces have been built, specially adapted for the manufacture of Bessemer iron.

After quitting the Walker Ironworks in 1850, Mr. Bell joined his father-in-law, Mr. Pattinson, and Mr. R. B. Bowman, in the establishment of chemical works at Washington, about eight miles from Newcastle. Having studied chemistry, Mr. Bell was entrusted by his partners with the designing and laying out of the Washington Works, which soon became among the most extensive of their kind in the north of England. It was here that his other firm, Bell Brothers, established the first works in Great Britain for the production of aluminium. When its manufacture was commenced at Washington in 1858, aluminium was produced from the ordinary ammonia alum of commerce—a nearly pure sulphate of alumina and ammonia. Exposure to heat drove off the water, sulphuric acid, and ammonia, leaving the alumina behind. This was converted into the double chloride of aluminium and sodium by a process devised by M. St. Claire Deville, of Paris, and the double chloride was subsequently decomposed by fusion with sodium. Subsequently another raw material, known as Bauxite, from the locality where it is found in France, was adopted at the Washington Works with complete success. The manufacture of aluminium at Washington has, owing to the limited demand for this metal, unfortunately been abandoned. In speaking of the then comparatively unknown product before the British Association in 1863, Mr. I. L. Bell stated that, "As a substance for works of art, aluminium appeared to be well adapted, when whitened by means of hydrofluoric and phosphoric acid, as it runs into the most complicated patterns, and has the advantage of preserving its colour, from the absence of all tendency to unite with sulphur, or to become affected by sulphuretted hydrogne, as happens with silver." The malleability, ductility, and capability of being finely divided, and engraved upon, along with its great strength, induced Colonel Strange, of the Royal Astronomical Society, to recommend the adoption of aluminium bronze in the theodolite used in the trigonometrical survey of India, and Mr. I. L. Bell, in a paper read some years ago before the Mining and Mechanical Engineers of the North of England, recommended its use for safety-lamps.

The intimate personal connection of Mr. Bell with the iron trade of Cleveland did not commence until 1852, when he commenced, conjointly with his brothers Thomas and John, the Clarence Ironworks on the Tees, opposite the town of Middlesbrough. The main seam of the Cleveland ironstone had been discovered two years previously by Mr. John Vaughan, who, in conjunction with Mr. Bolckow, M.P., had erected at Middlesbrough in 1851 the first furnaces built for smelting the ironstone contained in that seam. The next to commence works on the banks of the Tees were Messrs. Elwon and Company, who were building the Cleveland furnaces at South Bank when Mr. I. L. Bell and his two brothers commenced their works at Port Clarence. To Mr. Bell, therefore, belongs the honour of having been one of the first to inaugurate the colossal system which now bears the name of the Cleveland iron trade. The Clarence Works were built on the Clarence Railway, which connected the port of that name with the great South Durham coalfield. They consisted originally of only three furnaces, which were at the time of their blowing (in January, 1854) the three largest blast furnaces in the north of England. Each furnace was 47½ ft. high, and had a capacity of 6,174 cubic ft. Up to the time little had been done in applying the escaping gases as a means of heating the blast, Mr. John Vaughan (who had made experiments in that direction) having discontinued its use from the trouble involved in cleansing the stove pipes. Mr. I. L. Bell, however, was so impressed with the importance of having the air highly heated, that he caused the gases escaping from the furnaces to be applied to the air-stove at the Clarence Works, and from the high temperature obtained, and the increase of regularity, the consumption of coke was soon reduced from 38 and 40 cwt. to 28 and 30 cwt. per ton of iron made. No considerable increase in the size of the blast furnaces built in Cleveland was carried out until the late Mr. John Vaughan built in 1862 a furnace 75 ft. in height, and having a cubical capacity of 11,985 ft. To Mr. Bell an improvement in the performance of the furnace as compared with those of smaller dimensions was reported by Mr. Vaughan; and the former was so satisfied of the superiority of the change, that he had plans immediately prepared for a pair of furnaces, each 80 ft. in height and of 15,500 ft. cubical capacity. When they were put in blast these were the largest furnaces built in Cleveland, and their increased cost was found to be much more than compensated by the increase of yield, and the economy of fuel which they effected. Since that time, however, furnaces have been built at the Ferry-hill Ironworks with a cubical capacity of 50,000 ft., and towering to a height of 105 ft. from the bottom of the hearth. The latter furnaces have not yet been put into blast, but their performance is expected by their designers to be more economical than that of any other furnaces built in the district; but on this point considerable diversity of opinion prevails.

The distinguished position which the Clarence Works have already acquired, is likely to be more than maintained in the future. There are now ten furnaces in operation, and it is intended to build two others at present, which will make the works among the largest and most productive of their kind in the world. It is true that Essen with its 16,000, Seraing with its 8,000, and Dowlais with its 10,000 workmen, are each larger establishments than the Clarence Works will be in their completed form; but these notable works do more than merely produce pig-iron, whereas the Clarence Works do not follow the manufacture of pig-iron into any other branch of production. There are also at the present time works with quite as many furnaces as the Clarence Works will have when completed. Dowlais has now eighteen blast furnaces, and Gartsherrie in Scotland has sixteen, but at both of these works the furnaces are of much more limited size and capacity than those of the Clarence Works. None of the Welsh furnaces are capable of producing more than 10,000 to 12,000 tons of pig-iron per annum, and the Gartsherrie furnaces are rather under than over that capacity, while the Clarence furnaces are each capable of yielding 16,000 to 20,000 tons of pig iron per annum, thus allowing for the 12 furnaces an aggregate annual yield of fully 230,000 tons; which, with the make of their furnaces at Walker and Washington, will bring up the make of this firm to about 275,000 tons a year. At the prices which prevailed over last year the value of this huge product would not be less than £1,100,000 to £1,200,000, while on the basis of the prices of 1873, it would represent a total value of close on £2,000,000. The probabilities at the present moment appear, therefore, to point to the conclusion that within the next few years the firm of Bell Brothers, of which Mr. I. L. Bell is the head, will produce more iron than any other firm in the world.

But it is not alone in his capacity of a pig-iron manufacturer, that Mr. I. L. Bell occupies the position of a great industrial magnate. He and his brothers are among the largest colliery owners in South Durham, while they have also extensive ironstone mines in Cleveland and limestone quarries in Weardale. In a paper which he read a number of years ago, before the Mining and Mechanical Engineers of the North of England, Mr. Joseph Bewick declared, that "to Bell Brothers, more than to any other firm, is due the merit of having fully and effectually developed at this period (1843) the ironstone fields of Cleveland." On the 19th day of October, 1850, the Skinningnove mines in Cleveland were transferred from Messrs. Bolckow and Vaughan to Messrs. Losh, Wilson, and Bell, of the Walker Ironworks, who continued to work them until 1857, when they were again transferred to the Messrs. Pease, of Darlington. The highest quantity of ironstone raised from these mines by this firm was 6,025 tons of 22¼ cwt. each.[1] At the period of opening the Clarence Works on the Tees, Messrs. Bell Brothers commenced to work the Normanby mines in Cleveland, and in 1856 the vend of iron ore from these mines was 137,575 tons. Subsequently they acquired large royalties, where they commenced what is now known as the Cliff and Skelton mines; and within the last two or three years they have opened out the Skelton Park mines near the village of that name, about three miles from the popular and finely-situated watering-place of Saltburn-by-the-Sea. From their different ironstone mines, Messrs. Bell Brothers raise about a million tons of ironstone per annum,

[1] *Vide* Marley on "The Cleveland Ironstone."

being fully a sixth part of all the ironstone raised in the district. They do not, however, absorb the whole of this enormous output in their own furnaces. Over and above what is supplied to them, the firm are under contract to supply ironstone to other pig-iron makers who may not be fortunate enough to have mines of their own. From their collieries in South Durham, Mr. Bell and his brothers raise over 600,000 tons of coal per annum, the greater part of which is converted into coke; while from their limestone quarries at Stanhope in Weardale, they extract about 100,000 tons of material for fluxing the ironstone in the blast furnaces.

Commercially, therefore, Mr. Bell's interests are as much identified with the coal trade as with metallurgical industry, and on behalf of both, as we shall have occasion to show, he has done yeoman service.

Mr. Bell first came prominently before the public as a writer on the iron trade, when he read a paper before the British Association at the Newcastle meeting in 1863, "On the Manufacture of Iron in connection with the Northumberland and Durham Coalfield." In that paper he directed attention to the conditions under which the iron of Cleveland was produced, and to the remarkable rapidity and enterprise with which the resources of the district had been developed. It was justly considered as one of the most important, if not the most important, contribution that had been made up to that time to the history of the north of England iron trade, and at once stamped the author with the weight of authority. Numerous other papers on various phases of the same subject have subsequently been communicated by Mr. Bell to the "Transactions" of the Institute of Civil Engineers, the Mechanical Engineers, and the Chemical and other scientific societies. It is, however, to the "Transactions" of the Iron and Steel Institute that Mr. Bell has contributed the most valuable results of his experience and observation. He was one of the founders of that Institute in 1868, and proposed the resolution upon which the establishment was based. That resolution, which Mr. Bell proposed at a meeting of the North of England Ironmasters' Association held at Newcastle, was as follows:—"That this meeting approves of the proposition contained in the paper read by Mr. Jones, relative to the formation of an Iron and Steel Institute, and requests that a provisional committee be nominated, consisting of the following gentlemen, viz.—Mr. Edward Williams, Middlesbrough; Mr. J. L. Bell and Mr. James Morrison, Newcastle; Mr. David Dale, Darlington; Mr. J. T. Smith, Barrow; Mr. W. Fletcher, Workington; Mr. Pattison, Warrington; Mr. G. J. Barker, Chillington; Mr. Walter Williams, Tipton; Mr. William Mathews, Dudley; Mr. W. S. Roden, Stoke; Mr. Robert Heath, Stoke; Mr. W. Menelaus, Dowlais; Mr. A. Brogden, London; Mr. R. Fothergill, Mr. F. Kitson, Sir J. G. Alleyne, Bart., Butterley; Sir John Brown, Sheffield; Mr. Neilson, Glasgow; Mr. Samuelson, Banbury; and Mr. John Jones, Middlesbrough."

From its earliest beginnings, Mr. Bell has taken a very conspicuous part in the business of the Iron and Steel Institute. One of the first papers contributed to the "Transactions" of that body was from the pen of Mr. Bell. It was read in the autumn of 1868 to the first provincial meeting of the Iron and Steel Institute, held at Middlesbrough, under the presidency of the Duke of Devonshire. The subject was, "The development of Heat, and its appropriation in Blast-furnaces of different dimensions." This was one of the first public attempts in this country to examine scientifically the real nature of the conditions required in smelting iron.

Mr. Charles Cochrane, of the Ormesby Ironworks near Middlesbrough, had previously (in the same year) read a paper on the same subject before the Society of Mechanical Engineers, pointing out that the actual quantity of coke necessary in a blast-furnace was that demanded for the reduction and carburizing of the iron, which he estimated at 7·43 cwts. per ton, and expressed a hope (in the discussion which followed) that by increasing still further the dimensions of the blast-furnace, enough heat might be conveyed into the furnace with the blast, to enable a ton of iron to be produced from Cleveland ironstone with 13 cwt. of coke.

Mr. Bell disagreed with the latter conclusion, and with a view of making himself thoroughly acquainted with the utmost possible limits of economy in the fuel required for iron-smelting, he commenced, to quote his own words, "a very long series of experiments to determine, if possible, the nature of the reactions which take place among the substances dealt with in the manufacture of pig-iron." The result of these experiments he communicated to the world in a volume of 435 pp.[1] published in 1872, and acknowledged to be the most complete and masterly work of its kind that has ever been written. In his introduction to this work Mr. Bell says, that "apart from practical difficulties which may beset the use of furnaces enlarged beyond a certain size, it is obvious there is a positive loss in an expenditure on erections which do not ameliorate the operation, or yield an adequate increase of work. The same objection is equally applicable to heating the blast beyond that point where the additional temperature may be rendered useless from the nature of the chemical action involved in the process. Upon these two points some diversity of opinion exists in the minds of manufacturers themselves, who therein, up to this time, have received no assistance from men of purely scientific pursuits. In the absence of such help the following pages are offered, as a contribution to what has already been written upon this very important branch of British industry, for the use of those who feel an interest in the subject." It may be added, as showing the value attached to Mr. Bell's elaborate work, that it has been translated into German, French, and other European languages, for the use of continental metallurgists.

It was due to his distinguished position as a metallurgist and chemist, and to the very valuable services he had rendered to that body, that he should in 1872 be elected president of the Iron and Steel Institute, in succession to Mr. Henry Bessemer, the well-known inventor of the steel-making process which bears his name. This was the highest honour which the iron trade of the United Kingdom could confer, but it was one which Mr. Bell could worthily sustain, even in following such men as the Duke of Devonshire and Mr. Bessemer. Those who were privileged to attend the first provincial meeting of the Iron and Steel Institute over which Mr. Bell presided in Belgium, will remember with feelings of satisfaction the extraordinary success that attended the meeting—a success that was in no small degree owing to Mr. Bell's conduct in the presidential chair. His intimate knowledge of the French language enabled Mr. Bell not only to deliver his presidential address in French, but also to interpret to Englishmen the remarks of the French and Belgian engineers and iron-makers who took part in the meetings, while he was able with equal facility to render in French the observations of Englishmen. In this way much of the awkwardness and confusion that would otherwise have been liable to arise from an international gathering was avoided. Mr. Bell's presidential address at Liége reviewed the relative advantages possessed by England and Belgium in industrial competition, making a comparison of the varying rates of wages paid in the two countries, and the more prominent distinctions in their natural resources. All his deductions tended to the ultimate conclusion "that Great Britain owes her pre-eminence as an iron-making nation, not so much to her ability to work coal greatly below the cost of that obtained from the mines of Belgium, France, or Germany, but because she possessed what hitherto may have been regarded as unlimited powers of production in respect to her fuel." It will be remembered that the festivities which took place in connection with the visit to Belgium of the Iron and Steel Institute terminated in a splendid reception by the king at the royal palace in Brussels; and it was an interesting if not an instructive sight to see the most advanced and intelligent "industrial" of the age, presenting all the members of the association over which he presided, to a monarch whose predecessor was partner with Cockerill in the great works at Seraing, and who himself had taken an active and intelligent part in stimulating the industrial resources of his kingdom.

Mr. Bell again presided, during his second year of office, over the Barrow-in-Furness meeting of the Iron and Steel Institute in September of last year. Although in some respects this meeting came short of that held at Belgium, it was one of a highly successful character, and did a good deal to promote an international acquaintance with the conditions involved in the manufacture of Bessemer iron and steel. Mr. Bell's second year's presidency of the Institute terminated with the Barrow meeting, and the council appointed Earl Granville as his successor. During the two years' presidency of Mr. Bell more than 200 new members have been added to the ranks of the first scientific association of its kind in the world, and its prestige in other respects has been more than maintained.

Allusion has already been made to Mr. Bell's researches into blast furnace phenomena. This, however, is not his only great industrial work, nor are we sure that, judged from a purely utilitarian point of view, it is even his principal achievement. He has travelled in France, Germany, Belgium, Holland, Sweden, Poland, Spain, and other continental countries, for the purpose of studying their industrial relations; and last year he added much more to the immense storehouse of his knowledge on this subject, by a two or three months' tour in the United States. When we say, then, that there is scarcely a single iron or steel

[1] "The Chemical Phenomena of Iron-smelting: an experimental and practical examination of the circumstances which determine the capacity of the Blast-furnace, the temperature of the air, and the proper condition of the materials to be operated on."

industrial establishment of any note, whether at home or abroad, that he has not visited for himself; that there is scarcely a single branch of metallurgy that he has not studied in all its bearings; that there is no question cognate to that of the iron and steel manufacture that he has not more or less investigated; and that in one and all of these labours he has had special facilities for carrying out his purpose, we can fairly claim to pronounce Mr. Bell the most cosmopolitan as well as the most intelligent metallurgist of his age. Any expression of opinion coming from one who has so thoroughly studied the industrial situation of the world, must come with authority. Whenever he speaks on subjects of this character, Mr. Bell is listened to as if he were an oracle. His knowledge penetrates into matters that are little familiar to others. Hence he is called upon, when occasion arises, to throw light upon questions that are involved in obscurity, and to point out a pathway for the removal of industrial difficulties. He was one of the principal witnesses before the Commission appointed in 1873 to inquire into the subject of the coal famine, and before the Royal Commission that dealt with the probable extent and duration of our coal supplies, three years previously, he was examined at great length, and gave much valuable evidence. All the labours undertaken by Mr. Bell—and their name is legion—have apparently tended towards one result. His great, if not his sole aim, has been to discover the weak point in the industrial armour of the British manufacturer, and to maintain the position of Great Britain as the first of industrial nations, by the introduction of every possible economy, whether in the raising of the raw materials from the bowels of the earth, in their elementary stages of reduction, or in their ultimate conversion into the finished commodities required for the purposes of commerce. He has taken an active and intelligent interest in the great question of mechanical puddling, and this formed to a large extent the subject of his address at the May meeting of the Iron and Steel Institute in 1874. He is one of the largest coke producers in the county of Durham, where some 47 per cent. of all the coal raised (over 17,000,000 tons per annum) is absorbed in the manufacture of iron, and he has expended much labour and capital in trying to overcome the waste connected with the present system of manufacturing coke—a system that leaves only 57 to 60 tons of coke, where there should be about 70 tons per 100 tons of coal used. At the collieries owned by the firm of which he is the head, numerous experiments have been made with Appolt and other coke ovens, with a view of reducing this waste; but hitherto it has been found that any economy of fuel is followed by a deterioration in the quality of the coke. To the statistical aspects not less than to the more purely scientific aspects of the coal and iron trades, Mr. Bell has devoted much application, and to almost every learned society in Britain he has made communications dealing with this phase of industry.

But even the scientific and statistical phases of the greatest industries of the age fail to exhaust the wide domains in which Mr. Bell has laboured. He has been conspicuous at the meetings of the British Association and of the Social Science Congress; and at a meeting of the Economy and Trade Department of the latter society in September of 1870, he remarked in the course of a discussion which took place on arbitration as a solvent of trade disputes, that "it was by no means proved that co-partnership could be said to be free from all danger of disputes between capital and labour. He could well conceive many instances in which such disputes might arise. Anyone accustomed, as he had been for many years, to the various operations of manufacturing, would know that from time to time masters were compelled to take steps which might prove the reverse of successful. Large sums were often laid out in the erection of costly machinery, and he need not say that before such expenditure was undertaken it was with the conviction that such implements would be useful, advantageous, and profitable. At a very early period, he himself urged upon his colleagues in the iron trade the desirability of adopting conciliation, and looking at the great losses sustained by strikes, by masters and men, it was most desirable to avoid them by following such a plan as that shadowed out by those Courts of Conciliation."

The labours and researches of Mr. Bell have been rewarded by many signs and tokens of appreciative recognition. In 1874 he was admitted a fellow of the Royal Society, and the previous year he was elected an honorary member of a learned society in the United States—a distinction which in his case had only been accorded for the second time; upon which occasion Mr. Abram Hewitt, the United States Commissioner to the Exhibition of 1862, remarked that Mr. Bell had by his researches made the iron-makers of two continents his debtors. His recent visit to the United States may almost be described as a triumphal progress, which culminated in banquets given to him at Philadelphia and at Bethlehem in December last by the American Iron and Steel Association. On one of these occasions Mr. Bell was presented with an address, in which he was thus referred to:—"We honour Mr. Bell because he has done so much to make the iron business honourable. The son of an ironmaster, he inherited a position in the trade which might have satisfied his ambition without any special effort for its improvement; but from his early youth he carefully prepared himself for the intelligent administration of a great business by scientific training at the best schools, and by patient investigation of the principles which underlie the intricate processes of manufacture. Fortunately, perhaps, for himself and the world, his career has been identified with the most marvellous growth of productive industry, that of the Cleveland iron region, of which history affords us any knowledge; and to this development he has largely contributed by his intelligence, his scientific training, and his rare powers of patient investigation. By these labours he has fairly won for himself the highest position which, in our special department of industry, can be attained by any man, that of President of the British Iron and Steel Institute, the most enlightened and powerful organization for the advancement of a purely industrial interest which any nation has yet devised. In the course of his labours he has instituted an exhaustive series of experiments upon the operations of the blast furnace, and its chemical phenomena, the results of which he has embodied in an elaborate treatise, which is justly regarded as the most valuable contribution in our day made to a knowledge of the laws governing the smelting of iron; and leaving but little to be done in that direction by future investigators. While his successful acquisition of knowledge, and the practical skill with which he has applied it to useful purposes, would entitle Mr. Bell to very great and deserved distinction, to us his chief merit lies in the fact that he has not kept his acquisitions to himself, or even to his own country, but has made haste to share with all the world the useful results of his labour, thus taking himself out of the category of a mere man of business labouring for his personal advancement, and enrolling himself among the benefactors of mankind. And to Americans he has a special claim to interest, not merely that he has his home at 'Washington, in the county of Durham,' whence came the family of the 'Father of his Country,' but that he dispenses there a generous hospitality, which makes the patriotic pilgrim and the wandering ironmaster feel that they have returned to the home of their ancestors."

We cannot here enter at length into other phases of Mr. Bell's career. Suffice it to say that he was elected one of the members for the county of Durham in February, 1874, and shortly afterwards was unseated on petition, along with his colleague, Mr. C. M. Palmer. At the election which followed, Mr. Bell was opposed and defeated by Sir George Elliot, Bart., so that his valuable experience and exceptional talents are lost to the House of Commons. In political creed he is a thorough Liberal.

Among his other offices and engagements, public and private, Mr. Bell is a director of the North Eastern Railway, president of the Cleveland Mine-owners' Association, director of the Middlesbrough Royal Exchange, vice-president of the North of England Institute of Mining and Mechanical Engineers, vice-president and member of council of the Iron and Steel Institute, and a member of the Newcastle Corporation.

ARTIFICIAL SUBSTITUTES FOR STONE.

TO those accustomed to travel much in other countries, who as they go from place to place, go with watchful eye and observing mind, there is nothing perhaps so suggestive to them as this, that certain processes or modes of manufacture, methods of working, of directing labour, and of economizing it, or the materials upon which it operates, are carried on with manifestly good results; and yet are, so to say, so thoroughly localized that they are almost unknown at but very short distances from the points at which the traveller meets with them; and "across the channel," as the phrase goes, are entirely unknown. Many of our travelling readers of the observing, thinking class we have above alluded to, could point out numerous instances in proof of this; and it is one of the many benefits which travellers could perform to society if, when such cases were found, a "note" was taken of them, and transmitted to the pages of a journal such as this. We throw out the hint to some of our readers who we know do travel, and who also,

we know, notice as they go. In our present paper we purpose devoting a few brief paragraphs to the subject named at the head of our article. We begin with noticing the system of artificial stone-making, invented by M. Coignet of Paris, worked out on a most extensive scale, and in a variety of methods which were really as ingenious as they were practically useful, during a period we may say of years, throughout which it is scarcely an exaggeration to say that they were almost unknown to us here "across the channel." For our part, after being introduced to the inventor, and made acquainted by him with but a little of what had been done by means of his system of working, we had given to us a most striking exemplification of the truth of what we have just above stated, and which, put in homely language, may be thus stated, that "next door a most ingenious and in every way a most important process may be carried on for years, and we the immediate neighbours know nothing of it."

In a succeeding paper, when describing the process of forming artificial stone by blocks of concrete in which the hydraulic "limes" are the bases, or of concrete, in which the hydraulic "cements," whether those be of the natural or of the artificial kind, we shall have occasion to point out the principle upon which their formation depends, or is supposed to depend, for there is as yet much uncertainty connected with the whole subject. In the formation of blocks of artificial stone in which the hydraulic "limes" have been employed, the difficulty has been to find proportions which afford materials calculated to resist the action of the weather, and which do not also shrink when put together. In order to overcome these, the hydraulic "cements" have been employed, with much greater success, no doubt, yet without overcoming in a complete and satisfactory way the difficulties which have so long troubled practical men.

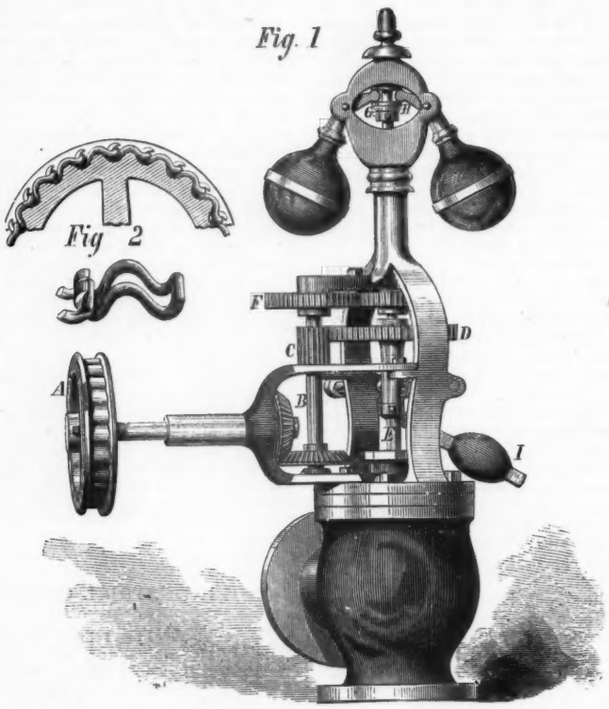
M. Coignet, believing that one great cause of the difficulties here alluded to, was the method generally used of forming the blocks by moulding them, conceived the idea of giving up this process altogether, and of falling back entirely upon the principle of "agglomeration." Hence the name "bétons (or to use the English equivalent, concretes) agglomérés." By the use of the method of moulding, the materials being used of necessity in the form of a paste or lime, more or less adhesive according to its constituents, the employment of a large percentage of water was of necessity involved, the hardening of the blocks depending upon the rapidity of the "setting," and this again unfortunately acting in the direction the very opposite of that which was required, tending to separate the particles, and to diminish the rapidity of the setting. Now, by doing away with the process of moulding, and by adopting that in the first instance of thoroughly mixing the materials and thereafter ramming them closely together by simple means, M. Coignet dispenses with a very large proportion of the water hitherto used in the formation of blocks of artificial stone, and obtains these blocks of such a hard and dense character that they are capable of resisting any degree of severity of weather, whether that be of rain or frost; the "set" is also rapid and more decided, and the material, in short, possesses all the qualities of the best stone, and others, moreover, which even that does not in many instances boast.

The materials, and the process by which they are formed into blocks of any size and of any design, however elaborate, are, it may be said, of the simplest character, easily obtained and as easily worked. The base is sand, so that if the soil in the neighbourhood of the works to be executed is of this character, the expense is reduced to a minimum. In point of fact most extensive contracts have been undertaken and carried out without a single mishap in neighbourhoods where the material cost nothing but simply that of its excavation. The sand is passed through a machine of simple construction, as easily worked as an ordinary pug-mill in a brick-yard—which in many respects, in fact, it closely resembles—being mixed with a small proportion of hydraulic cement—that known as "Portland" being used by preference—and a small quantity of water. The whole are thoroughly mixed, and rendered perfectly pulverulent in this machine. From this it is passed and thrown into moulds made in the most simple manner, these being strong enough to resist the repeated blows of an appliance somewhat like a pavior's rammer. The materials are put into the moulds in a comparatively thin layer, and subjected to a thorough beating or ramming. In an exceedingly short space of time these become "set," and form a hard, impervious stone. The moulds are now removed to a further distance up the excavation—we are supposing work of a simple character to be under process of execution, such as a drain, or sewer, or plain wall. The mixed materials are put in rammed as before, and thus the work proceeds with an ease and rapidity which is certainly calculated to surprise those accustomed to work other systems. In the case of work of the character such as we have named above, the apparatus or moulds, if they can be given such a dignified name, are of the simplest character. We have seen sewers and retaining walls of the most imposing dimensions, constructed—if the term is applicable to the system—by labourers of the most ordinary character, possessing no pretensions to the title of "skilled," and the whole process carried on, as above stated, with an ease, precision, and certainty which was most gratifying to a practical man. Nor is the process much more complicated in the case of elaborate structures. No doubt, where "design" comes into play, the moulds are of a more elaborate kind, but the mere work of "constructing" is just as simple as above described, and it is as applicable to the construction of vast and imposing, as it is to that of small and simple buildings. We have gone—slightly to parody the words of one of our most popular poets—from "turret to foundation-stone" (although the last word was by no means applicable to a structure in which not a single stone was used) of a large mansion, which in point of fact was monolithic throughout, being composed of but one mass, without a single joint in it; and one of the largest churches in Paris is built of this material, which is also quite monolithic in character. We have said that it is applicable to all kinds of work in which stone or brick are used; vast lengths of sewers have been formed of it, and it is also applicable to work in which neither stone nor brick could be easily, certainly not economically, used—as for example in the lining of reservoirs, and in fact the formation of artificial lakes. We do not write in the "Cambyses vein" when penning all this—we could pen something still more decided; we are but giving after all a very sober account of a process which has at all events been wonderfully successful abroad, whatever may be the future of its history with us. We shall have yet a few words more to say about it in a succeeding paper.

THE INDUSTRIAL CONDITION OF BULGARIA.

KANITZ reports favourably on Bulgaria and the Bulgarians, the country being rich and the Bulgarians (distinguished from the Servians) attached to industrial pursuits. The development of these advantages is hindered by the action of the Turkish government. Two-thirds of the cultivated land is laid down in maize; corn, rice, tobacco, cotton, wine, and table vegetables are also raised. The latter are mostly haricot beans, onions, and garlic. Onions replace the potatoes of western diet. The silkworm is successfully cultivated; the Bulgarian grains, improved by crossing with the Persian and Syrian, are sold at high rates to Italian dealers. Rapeseed, flax, and madder are easily grown. On the southern slopes of the Balkan are a large number of rose-farms, the production of "attar" being an industry as profitable as it is fragrant. In this district also the dealings in walnut wood are important, trade being done to the amount of 3,000,000 piastres a year. The walnut stems reach a great size, and are of fine quality. They are much sought after by French cabinet-makers, who frequently pay high prices for them. But for the repressive action of the Turkish government both these branches of trade would reach far larger proportions. Raki (brandy) and distilled spirits are made in some quantity, and cattle abound, the country being rich in horses, oxen, buffaloes, sheep, and goats, while poultry is plentiful. Horses and cattle are both small. For draught, use is mostly made of the buffalo, as it possesses three times the strength of the Bulgarian ox. Mineral springs are found in several places. There are great stores of untouched mineral wealth. A little iron is raised from the celebrated strata of Samakov, but the methods adopted are the most primitive imaginable, and the winnings are inconsiderable. The country is eminently adapted to industrial enterprise from its supply of coal, its abounding water force, and its mild climate. The inhabitants have an innate disposition for the industrial arts and great constructive talent; this is evidenced not only by their ordinary dwellings but also by their ingenious waterworks, their bridges, and their churches. The finest bridge in Bulgaria, the Jantra bridge near Bela, was designed and executed by a couple of architects from the Balkan, whose technical training had been of a most primitive kind. So in the large towns we see churches, mosques, and synagogues, with boldly-designed cupolas, minarets, &c., which have been erected by untaught natives who scarcely knew the use of a black-lead pencil. Their industrial talent is also amply manifested by their iron and silver work, their tapestry and embroidery, their muslins and their wood carving; and could the evil influences of their present government be set aside, and this ingenious people brought into direct contact with western civilization, Europe would be much the gainer. *Oesterreichische Monatsschrift für den Orient, Jan. 15.*

Fig. 1



ORD'S CUT-OFF GOVERNOR.

THIS invention is a graduated steam cut-off, conveniently adapted to most engines in general use, and designed to take the place of the common governor. In its construction the inventor claims that the valuable advantages of sensitiveness, isochronism, strength of action, durability, simplicity, and cheapness, are all included. How such a result is obtained we shall explain as we proceed, reference being first necessary to the details of the device which are represented in the accompanying illustrations.

Fig. 3

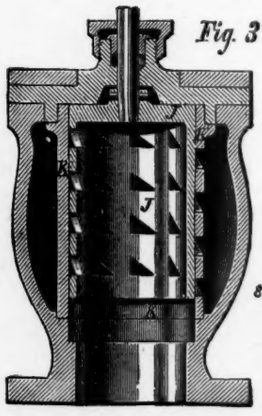
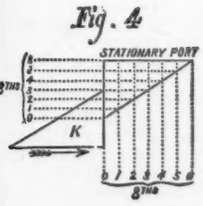


Fig. 4



In fig. 1 the complete apparatus is shown in perspective. Motion is communicated to it by the wheel, A, which, it will be observed, is provided with a corrugated periphery. Into the indentations of the latter fit the links of a chain, which is employed to transmit the power, in place of the ordinary belt. In fig. 2 is represented one of these links, and also a section of the wheel and chain. This device, we are informed, secures a smooth, noiseless, and positive action. The chain is also said to be cheap, readily applied, and durable.

At the inner extremity of the shaft of wheel A, is a bevel gear, by means of which motion of the same speed is transmitted to an upright shaft, B. Upon the latter is a pinion, C, which, being to the wheel, D, as 1 to 4, causes said wheel, and consequently the valve stem, E, to rotate once to every eight strokes of the piston.

Also on shaft B, is a wheel, F, which, by the gear shown, rotates the balls. Below the inner ends of the arms of the latter is a fixed collar, G, on the valve stem, E, and above is a loose collar, H, into grooves in which the extremities of the arms fall, turning the same upon the stem with them during their revolution. It will be plain that, as the balls fly outward, the arm ends will press down on the collar, H, and consequently push the valve stem also downwards.

I is a level and weight, suitably pivoted to the frame and provided at the inner end with a gear sediment, which works in a rack upon a sleeve sliding upon the valve stem. By moving this weight, speed can be increased or lessened, or the device may be used to open the valve in starting the engine.

The valve arrangements are shown in sectional detail in fig. 3. There is a movable valve, J, secured to the extremity of the valve stem, and a fixed valve, K, in which the former fits, within the steam chamber. In each cylinder are four horizontal rows of eight triangular orifices each, making thirty-two orifices in all, considered jointly, which open and close at every stroke of the piston. It will be seen by reference to the diagram, fig. 4, that by thus providing a valve with steam port openings, so arranged in connection with a movement that will give the necessary aperture to secure full boiler pressure at the beginning of each stroke of the engine, and which will close at any part of the stroke, according to the power required, that the supply of steam is regulated in an efficient and economical manner. Referring to the steam port, K, which is represented as moving to

the right, the upper corner overlapping the lower corner of the stationary port, and touching the horizontal line denoting three-eights, should the governor carry the valve in that line, it will intersect the perpendicular line corresponding to three-eights in the cylinder, which is the point where steam is cut off. Should, however, the engine be more heavily loaded, the balls will drop and give a corresponding increased opening, cutting off at a later period of the stroke. The increased pressure on the end of the valve stem, together with the changed position of the weight, secures the same rate of speed as when running light.

The valve has a limited up and down motion, and, when at rest, the moving cylinder takes against the steam chamber cover. The openings in the two portions of the valve do not then correspond, so that steam is thus shut off, and a means of safety provided, should anything occur to prevent the proper action of the governor. Similarly, if the movable valve should become disconnected, steam would be again shut off, as the valve would drop to a seat in the bottom of the chamber, and the orifices would not correspond. Steam from the boiler being around the exterior of the valve, the latter is perfectly balanced.

The inventor directs especial attention to the fact that steam is admitted to the cylinder at the point where the main valve opens to take steam. Consequently the degree of pressure acting on the piston valve is also applied to the end of the valve stem. This has a tendency to force the latter up and enlarge the opening, holding the engine to its speed, although the balls are not carried as high as when running light.

The parts of the valve are made of a fine grade of iron and fit perfectly true. No difficulty, we are informed, has been encountered through expansion. The inventor submits a number of laudatory testimonials from well-known firms in Cleveland, Ohio, with reference to the successful working of the device, which also obtained a first premium at the New Orleans Fair of 1873. *Scientific American.*

THE MINERAL INDUSTRIES OF ITALY:

FOSSIL COMBUSTIBLES—SULPHUR—SALT—BORACIC ACID—CHEMICAL PRODUCTS—ILLUMINATING GAS—MARBLES, ETC.[1]

IN Italy, the carboniferous series is but sparingly represented. The Italian slopes of the Graiian Alps contain some beds of anthracite, which recent geologists refer to that epoch, and there is a seam of coal at Cludenico, at the further extremity of the kingdom, on the frontier of Carinthia. Other districts with the same geological character have no coal, and very little combustible mineral of any kind—what there is, being of inferior quality. To provide for her industrial requirements, Italy is therefore obliged to import coal. The imports of coal have steadily kept pace with the development of her manufacturing resources, and in 1872 amounted to 1,037,409 tons (with a declared value of 51,170,450 lire[2]), the greater part of which came from England.

There are some beds of lignite, the utilization of which progresses but slowly, being subordinate to the local demand in the immediate vicinity of the beds. The employment of water-power, which the configuration of the peninsula renders general, permits the application of inferior descriptions of fuel to industrial purposes.

Anthracite is worked in the valley of Aosta. The Savoy anthracite is considered equal to that dug in Belgium, and gives an average of 21 to 23 per cent. of ash. Its use is restricted to domestic purposes and lime-burning. The output of 1872 amounted to 2,000 tons, and was valued at 20,000 lire, being the produce of the three mines in work up to that time.

When the railway is open from Pontebba an outlet will be provided for the produce of the colliery on the road from Rigolato to Tolmezzo, about forty-five English miles from Undine, which may then look forward to a considerable development.

In Trentine, near Mori, occurs a seam of coal interposed between beds of limestone, which geologists refer to the Jurassic era, but the coal is bedded so firmly, in a horizontal position, in compact rock, that all attempts to work it economically have hitherto failed.

The combustible fossils of the tertiary formation are of more importance. Foremost amongst them are the beds of bituminous lignite, which occur in the eocene and miocene deposits of Tuscany. The bituminous lignite of Monte Massi and Tatti burns without crepitation, and is not friable—qualities which materially enhance its value. Its heat-producing power is about three-fourths of that of the best steam-coal. The output of 1872 was 12,135 tons, and was valued at 131,691 lire.

It would appear to be of considerable importance to the industrial future of Tuscany. The Monte Rufoli works at Podernuovo, in the commune of Pomerance, yield a lignite with a heat-producing power of 4,523 calories, which, taking the heat of steam-coal as unity, is equivalent to 0·58.

There are also lignite mines at Monte Bamboli, whence no returns have been received; at Sarzannello and Caniparola, the output of which in 1872 was 6,734 tons, valued at 74,200 lire; some beds of bituminous lignite in the neighbourhood of Sienna, whence in the course of the last-mentioned year, the Monte Murlo mines extracted 16,904 tons, valued at 261,008 lire; a bed at Fontanamare in the ligniferous basin of Gonnesa, in Sardinia, where the output of 1872 amounted to 2,200 tons, valued at 36,800 lire; some valuable mines at Cadibona, which in the same year yielded 5,700 tons, valued at 75,000 lire; those of Nuceto and Bagnasco, of Puli and Valdagno, the produce of the two last in 1872 being about 15,000 tons of lignite and 3,500 of bituminous schist—besides some other beds which hitherto have not held out much promise.

Italy also possesses numerous large deposits of fossil wood of the lacustrine epoch. The largest deposit is in the Val d'Arno, between the Chianti and Casentino ranges. The bed of lignite at Castelnuovo di Massa is 12 metres thick. Its superficial extent appears very considerable, and the probable output is estimated at 100,000 tons per hectare (2½ acres English). The actual output at Castelnuovo was 10,000 tons in 1872; in 1873 it was 30,000 tons, valued at 311,600 lire. The total yield of the mines of the Val Gandino was 16,000 tons, valued at 160,000 lire. There are, besides, a few other beds.

The working of the peat-beds of Upper Italy is connected with the very existence of the glass and ceramic industries there, which, but for the cheap fuel thus placed within their reach, would be unable to make head against foreign competition. Peat is used also in the silk-mills in Lombardy, and also in the large iron-smelting establishments at Lovere, Dongo, and San Martino d'Aosta. The principal peat-beds are at Iseo, Bosisio, Colico, Angera, Lentale, Arona, Varese, Castelletto Vaprio, Venice, the lower Val d'Aosta, Avigliana, Abruzzo, and a few other localities. These supply the best peat. The total amount of peat dug in all Italy during the year 1872 is estimated at about 90,000 tons, valued at 1,500,000 lire.

The slopes of the Apennines, in the valley of the Po between Staffora and Reno, present a stratum of earth impregnated with petroleum, which shows itself sometimes in a liquid state amongst the marls and sands of the upper miocene and lower pliocene beds, sometimes in the form of gaseous emanations, which escape into the atmosphere. In the valley of Pescara there are beds of bituminous earth containing petroleum and asphalte, but the quality of the former is inferior to that of the Æmilia petroleums.

In the circumscription of the Gaeta there is a prolongation of the bituminous deposits of the valley of Pescara. The localities richest in petroleum are Rivanazzano (Voghera), Neviano de' Rossi, Val de Taro, Miano (province of Parma), Val di Riglio (Piacenza), Montegibbio, Tocco di Casauria (Abruzzo), Lettomanopello, and San Giovanni Incarico. In the communes of Colle San Magno, Rocca d'Arce, and Roccasecca, there are bituminous limestones suited for the extraction of asphalte, but they have not yet been much worked. There are extensive asphalte works in the mountains of Frosinone. The total yield of fossil combustible substances during the year 1872 amounted to 193,730 tons, valued at 3,252,658 lire. The industry gave employment to 4,743 hands.

The yield of sulphur during the last-named year was about 221,000 tons, valued at 26,120,000 lire. The value of the latter far exceeds that of any other mineral, and the output is inferior in magnitude only to that of sea-salt. It is worked in three different localities, Romagna, Naples (Avellino), and Sicily. The produce of the Romagna is equivalent to but one-tenth that of Sicily; Naples yields a fortieth only of the same.

The most important mines of the Romagna are those at Perticara, Marazzana, San Lorenzo in Zolfinelli, in Urbino, and Boratelle, Formignano, and Piajo in Cesenato. The process of extraction is generally effected with steam-machinery.

Some years ago a group of sulphur mines were in work in the province of Avellino. A portion of the sulphur is sold without undergoing any process of preparation, and is used for sulphuring vines. Other mines exist in Tuscany and in the Roman provinces. The classic region of sulphur, however, is Sicily, where the beds form a zone about 100 English miles in length with a maximum width of 50 miles. As a rule, the sulphur-mines are worked in a careless, slovenly fashion. In some of

[1] *L'Economista* (Florence and Rome), 17th Dec. 1874.

[2] The *lira* (plural *lire*) is of the value of a franc.

the most important, steam-machinery has been introduced for extracting the mineral and pumping water. Such progress as has been made is in part due to the mining-school at Caltanissetta. The exports of sulphur during the year 1872 amounted to 18,428 tons. The exports were chiefly to England, France, the United States, Austria, and the German ports. According to the estimate of an Italian engineer, Sig. Parodi, it appears probable that Sicily still contains in its subsoil some 200 million quintals of sulphur, which would suffice for seventy or eighty years at the present rate of production.

The mineral which gives the largest returns in Italy, and which furnishes exports to most European countries, not to speak of America and India, is common salt.

Italy abounds with this necessary of life, which is obtained from the littoral salines of Cagliari, Trapani, Barletta, Commachio, Porto Ferrajo, Corneto, and Ostia, and from the brine-springs of Volterra and Salsomaggiore, as well as from beds of rock-salt in Calabria and Sicily.

The most important salines are those at Cagliari, which are private property. Next come those at Tarentum, 31 in number, and then those at Marsala, 5 in number, and at Burano, near Venice. The salt is extracted by the old-fashioned method of evaporation.

Of the brine-springs, two only are now worked. One of these is at Salsomaggiore, and is private property; the other, at Volterra, belongs to the state, but has been leased to a company. The seven springs at Salsomaggiore yield daily 300 hectolitres of brine, of 13°; the six springs at Volterra can supply 3,000 hectolitres daily.

Of the deposits of rock salt, those of Lungro in Calabria, Cattolica, Cianciana, and Recalmuto in the province of Girgenti, and Nicosia and Leonforte, in the province of Catania, or rather of Caltanissetta, are worked only.

The saliferous deposits in Sicily, which nearly equal those of sulphur in extent, belong to the lower miocene, and contain rich beds of rock-salt, for the most part sufficiently pure in quality for immediate use. With improved means of communication, and more especially now that the Suez Canal is open, it will be possible to export largely, particularly to India, where rock-salt is preferred to sea-salt, so long as it can be delivered at a price under 18 lire per ton. The annual yield now amounts to about 2,000 tons for home consumption.

The littoral salines in Sicily yield annually about 70,000 tons of salt, which are almost all exported. Some cargoes are sent as far as India. The average cost on the spot is 1·70 lire per ton, to which 3·90 lire per ton must be added for carriage to place of shipment. The selling price keeps steady at 6·50 lire per ton, leaving a profit of 2·60 lire on every ton.

In 1872 the total yield was 241,744 tons, valued at 3,863,113 lire. Of these, 225,056 tons, valued at 3,553,205 lire, were sea-salt; 7,988 tons, valued at 35,408 lire, rock-salt; and 8,700 tons, valued at 274,500 lire, salt from the brine-springs.

The manufacture of sea-salt gave employment to 3,586 hands; the other branches of the trade together occupied 239 hands.

An article of mineral produce peculiar to Italy is boracic acid, which is obtained from the vaporous emanations arising from the Tuscan marshes, and forms a special object of export to England, where it is manufactured into borax for use in the potteries and glass-works, and for dyeing purposes. The chief centres of these emanations—called *soffioni*, and consisting of aqueous vapours, carbonic acid, sulphuretted hydrogen, boracic acid, and silicic acid of high temperature, averaging about 100° Réaumur—are in the province of Pisa and in the communes of Pomerance and Castelnuovo, at Massa Maritima and Montieri, in the province of Grosseto. The manufacturers of this acid are ten in number. The industry was started, in 1828, by Count Larderel at Monte Cerboli, and it is now carried on in the districts of Larderello, Castelnuovo di Val di Cecino, Serrazzano, Lustignano, Lago, Monte Rotondo, Sasso and Traval. In 1872 there were manufactured 2,750 tons, the value of which was 4,124,550 lire. Alum is manufactured at Montioni in Tuscany, at Tolfa near Civita Vecchia, and at Puzzuoli, near Naples. The manufacture is declining, owing to the employment of other chemical substances by dyers in place of alum.

The other chemical products of mineral origin in Italy are not of much moment; they consist of small quantities of sulphuric, nitric, and chloric acids, sulphate and carbonate of soda, &c. Altogether, the chemical products amount to 12,000 tons, with an estimated value of 5,000,000 lire.

Gunpowder is manufactured for military and sporting purposes, and for use in mining, to the amount of about 2,000 tons a year. The government makes its own powder at the mills of Fossano and Scapati. The rest is manufactured at private establishments. There are two new manufactories of dynamite, one at Cesano-Maderno, near Seregno, in Lombardy, and the other in the neighbourhood of Turin.

Illuminating gas is manufactured in some eighty gasworks distributed amongst the principal cities and towns of the peninsula. In 1872 the produce was estimated at 72,000,000 cubic metres of gas, the produce of 268,000 tons of imported coal.

A very important feature in the mineral productions of Italy are the limestone quarries in the Apuan Alp, in the valleys of Carrara, Massa and Serarezza, whence, not only all Italy, but the principal markets of the world besides, are supplied with marble for statuary and ornamental purposes.

The marbles are classed as *bianchi*, *bardigli*, *mischi*, and *brecce*.

The quarries now in work are 600 in number, of which 425 are Carrarese (15 of them for statuary marble), 70 Massese, and 90 to 100 Versiliese.

The *seghérie* are 100 in number, the *telai* 487, the *frulloni* 62. The total produce in the year 1872 amounted to 143,000 tons, valued at about 13,000,000 lire.

Other localities furnish striped marbles, like the *brocatello* of Sienna, and that called *giallo di Sienna*. Of these the annual yield is about 100 tons of all qualities.

Choice marbles are also found in the Pisan mountains near San Giuliano, in the province of Lucca. Alabaster abounds in the provinces of Sienna, Pisa, and Volterra. In 1871, the exports from Leghorn amounted to 7,376 quintals of alabaster in the rough state, besides manufactured articles of the same, valued at 584,010 lire.

Tuscany abounds in what is called *pietro duro*, chiefly used in mosaic work. Marble is very plentiful in Piedmont, especially in the province of Cuneo. Sardinia has its various ornamental and decorative marbles. Lombardy has marbles and alabaster. The Venetian provinces and Verona are very rich in marble. In the provinces of Parma and Piacenza are some quarries of beautiful and varied kinds. In Bologna the principal and most used marbles partake of the character of serpentine. Marbles and ornamental stones are in great abundance in the Marches, in the Romagna, and in Umbria. The Neapolitan provinces of Sicily are also very rich in this respect.

Valuable quarries of building-stone exist in Piedmont, in the Valtelline, in Sardinia, in Lombardy, in the province of Vincenza, in Tuscany, and in Rome.

Graphite and talc are found in Piedmont, asbestus in the Valtelline, whetstones in the Lombardy mountains between the Brembana valley and Lake Iseo.

Millstones are dug more especially in Lombardy. In 1873, only 24,930 lire worth were exported. The value of the imports of this article in the two years 1872-73 is said to have been ten times that of the exports.

Amongst the mineral substances found here and there in Italy, are included feldspar, kaoline, potter's earth and ochres of various kinds; some of the best known deposits are in the provinces of Verona, Sienna, Grosseto, Venice, and Rome, and in the islands of Sardinia and Elba; there are also quarries of soft stone, which is used for potters'-ware. Lithographic stone, steatite, pumice, emery, and Tripoli powder are not wanting.

In 1872, the output from quarries of all descriptions was valued at 21,573,306 lire. There were altogether about 3,000 quarries in work, giving employment to 17,000 hands.

There are a few manufactories of glass and earthenware bottles and other common utensils. The estimated annual value of the imports under this head is 8,500,000 lire. The glass and crystal manufactures produce an annual total of 10,810,000 lire.

The ceramic art is practised almost exclusively in Milan and Florence, by Richard and Ginori, who import the greater part of their kaoline. There are also manufactories of majolica and terraglia. The total yield of this branch of industry, including the choicest as well as the commonest wares, is valued at 9,380,000 lire per annum.

Brickmaking (manufacture of roofing and paving tiles, &c.) gives employment to some 7,000 kilns, the annual value of the produce being estimated at 25,000,000 lire.

The preparation of lime and cements of a more or less hydraulic nature, and of plaster, is carried on to a large extent, particularly in the Apennines and in Sicily. The number of small kilns so employed is about 4,000. In 1872 they manufactured 799,198 tons, valued at 13,879,774 lire.

Italy is very far from supplying her own wants in respect of the metals, and other mineral substances, as may be seen from the fact that in 1872 the imports under this head amounted to 1,320,087 tons, valued at 182,621,308 lire.

Computing the pecuniary results of Italian mineral industry from the declared value of the exports and the estimated values of the various products of her indigenous mineral resources, metals included, we arrive at a total of 100,668,411 lire.

The value of the annual imports of mineral produce, of all kinds, in Italy is about treble that of the exports.

GEMS OF INDUSTRIAL ART.—VASE.

THE PLOUGH—ITS HISTORY, CONSTRUCTION, AND MANAGEMENT.[1]

WE concluded our last article by detailing in brief fashion the advantages derivable from having the soil in a loose, well, and deeply mixed condition. Before proceeding to the investigation of the plough, with a view to see how far it is calculated to give us this condition, it will be well to glance at a few other points in connection with this loose and well-pulverized condition, and here we would give a vidimus or condensation of some particularly suggestive remarks on the subject, as stated in an admirable report by the New York State Agricultural Society. These bear on the relation which the lines of the mould-board of the plough have to the pulverization of the furrow slice by breaking or splitting it up into slices, and these slices having different directions, consequently break up the slice into corresponding cubes or rather parallelepipedons. To aid in the understanding of these we have specially prepared a series of illustrations adapted—with a view to make them more simple and easily understood—from some given in the report. We have already stated that in the majority of the ploughs in this country—and specially is it noticeable in those made and used in England—the object arrived at in the placing of the lines of the mould-board is the throwing over of the furrow slice at the angle of 45°, with its angles or edges straight and unbroken, and its surface glazed or polished, so to say, with the mould-board passing over it, and the body of the slice more or less compressed. This plough will present what an English ploughman dearly loves to see, a series of furrow slices, all the ridges of which are parallel to one another, and all the surfaces of the slices compact and unbroken. But we have already hinted at the fact, that to this "orthodox" school, there has lately risen

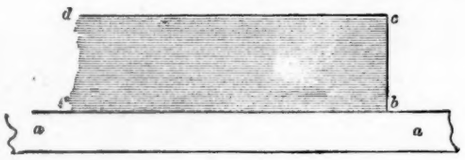


Fig. 43.

in opposition another, the teachers of which—and they have now many followers—hold that the soil should be pulverized by the plough, or rather the mould-board. Not that the advocates of the straight unbroken furrow slice do not believe in the pulverization of the soil, but they hold that it is the office of a succeeding implement or implements to do this, namely, the harrow, clod-crusher, &c., &c. The point at issue then between these two schools is whether the plough shall or shall not be the immediate implement for pulverizing the soil, rendering the

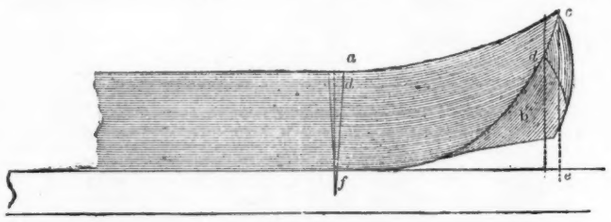


Fig. 44.

harrow one the office of which will be rather the mere covering over of the seed than that of pulverizing the soil. In America those who hold that the plough should be the immediate implement, are, if not the great majority of practical men, rapidly becoming so; and amongst them are the reporters to whom we have already alluded, and to whose remarks we now draw the special attention—and the subject is worthy of it—of the reader. If we suppose a series of sheets of paper or paste-board laid on a board or table, as *a a*, fig. 43, and being all of equal size and superposed the one exactly above the other, the end *b c* will be at right angles to the plane of the surface *c d*. If now the series of boards be held firmly at one point as *a*, fig. 44, by the fingers of

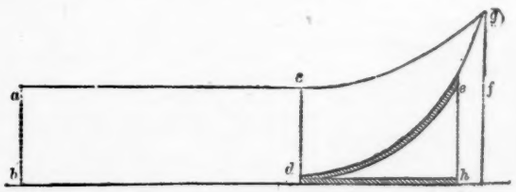


Fig. 45.

one hand, or nailed down as shown on the board, and the corner or outer edge, corresponding to *b c* in fig. 43, be lifted up, the end will assume a curve, the lower surface of which (*b*), being stretched out, will cause the sheets—they being free to move upon one another—to slide up on each other, so that at the extreme edge they will assume the form of a sharp angle at *c*, the extreme corner *c* being formed by the uppermost sheet *c d*, in fig. 43, and the next in advance the second sheet, and so on. By this successive advance of the sheets, caused by the bending up of the corner or outer edge, the end *c d*, fig. 44, is no longer at right angles to the upper surface, as in fig. 43, but at an angle such that if a perpendicular be dropped from the point *c*, and another from the point *d*, the distance between them will show how much the point *d* has receded from the point *c*. If the sheets at the corner be now released, in virtue of their elasticity they will spring back to the surface of the board corresponding to *a a* in fig. 43, and the end *c d* will then be at right angles to the surface *a*. These diagrams ingeniously represent the process through which the soil of a furrow slice passes when under the action of the mould-board of the plough. Although one not accustomed to the working of the plough would not be inclined to believe it, every observant ploughman knows it to be a fact that soils possess a certain degree of

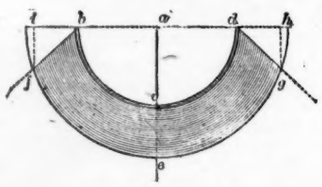


Fig. 46.

elasticity—varying more or less in amount, of course, according to the nature of the soil—and when subjected to a pressure tending to force the particles out of what we might call their normal line, when that pressure is removed, the particles will return more or less completely to their original position. Let us suppose *a b c d*, fig. 45, to be the depth of a furrow slice, the point of the share at *d*, and the point *e* resting upon the mould-board *d e*; further, supposing that the soil is most elastic, and the measure in force of that elasticity represented by the distance *e f* between the two perpendiculars dropped from the points *e* and *g*, or what is the same thing, the amount of force required in the action of the plough to overcome that elasticity, then it follows that all furrow slices will be split into slices or flakes at their lower edge, as *d c* in fig. 45, these slices being horizontal and corresponding to the sheets of paper in fig. 43.

[1] For the articles preceding see vol. i. nos. 4, 5; vol. iv. no, 22.

The upper edge as *g c* has no concern in the splitting force, inasmuch as it does not move through a space equal to *f e*, and "as that is the precise point where the elasticity of the slice is overcome, any less motion will fail to split the layers. It follows from this reasoning," say the reporters, "that every kind of soil should have a mould-board specially adapted to it, if we should obtain the greatest economy of power, because the more blunt the entering wedge, the greater would be the draught, and it would be uneconomical to use an entering wedge sufficiently blunt to flake up a stiff clay, for a light loam, where a much more acute angle will suffice. Still, if economy of power be not an object, a plough which will separate the most tenacious soils longitudinally will be sufficient for all soils that are less so." It will be obvious, on inspection with consideration of the diagrams, figs. 43, 44, and 45, and of these accompanying remarks, that the mere splitting up of a furrow slice as *b c d* in fig. 43, is not pulverizing its particles. A splitting in another

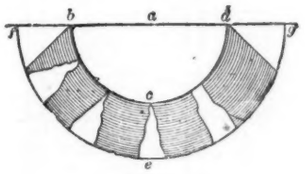


Fig. 47.

direction, and at right angles to this, will be necessary before the furrow slice is broken up into separate pieces. Let it be assumed that we have a plough so made that its twisting force will be sufficient to form a furrow slice as *a b c d*, fig. 45, into a semicircular shape, as *b c d* in fig. 46. While the furrow slice lay flat, the line *b c d* of the upper surface was equal in length to the line *f e g* of the lower surface; but in its twisted form the radius *a c* is less than the radius *a e*, and while the particles of soil are compressed between *b* and *d* they are elongated on the side *f g*. But they no longer form a complete circle terminating at the points *h i*, but fall short of these by the distances *i f*, *h g*; these lines, in which the furrow slice was flat, were parallel with each other as *a b*, *c d*, in fig. 45, but they now, in fig. 46, assume the acute angles *i b f*, *h d g*. The lower sides or *f e g* being under what engineers would call the force or pressure of tension, there is a point beyond which the cohesive powers of the soil, or its capa-

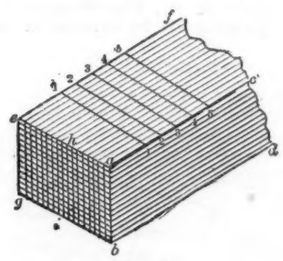


Fig. 48.

bility to resist this tensile force, will cease to prevent the fibres —if we may so say—being torn asunder; if then the twist is increased, the furrow slice, or section of soil, breaks or cracks as at *e*, fig. 47, the fracture being greatest at the outer circle *f e g*, where the stretch or tensile force is greatest, and gradually decreasing as it approaches the inner circle *b c d*; in the supposed case the twist is such that the fractures send the ends *b f*, *d g*, to be in a line with each other. By applying—by means of the mould-board—the twist at the proper point, the furrow slice is broken across. The result of the two systems of "cleavage," to borrow a phrase from a sister science, is illustrated in fig. 48, the adjustments of the mould-board having cloven the slice into layers as *a b c d*, the layers being parallel to the surface *a c f e*, and secondly split or cloven the slice into vertical slices as *h i*, in the end *a b*, *g e*, the cleavages crossing each other at right angles to each other as shown; thus, by the combination of the two breaking up the slice into a series of small blocks, in other words, pulverizing it. But having thus accomplished the breakage in two directions, it is possible to add another in a third. Thus, suppose the wing of the mould-board to be turned at right angles to the line of direction of the ascending slice *a b c d*, as in fig. 49, it would be compelled to change that direction to that as *b e f g*, but in doing this, the point *c*, or the particle of soil at that point, would have to turn a quadrant of a circle as *e c*, of which the centre would be the point *b*, this point *b*, or particle of soil at that point, only turning round the back particle of soil in the line of the dotted line *b c*, would move with a different velocity—the further from point *b* the greater the velocity—the continuation of the line of particle would thus be broken, and a fracture would take place at the point of *b*, as represented by *b c e*. The extent of this fracture as *c e* would be lessened, and it is only the slightest fissure that is required, by

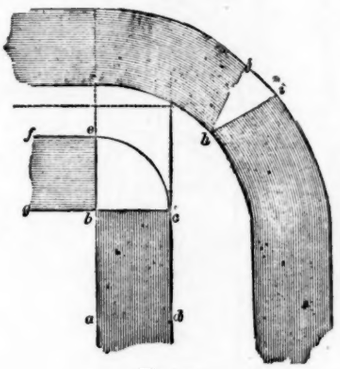


Fig. 49.

diminishing the angle of the wing of the mould-board (in *a b b g* it was a right angle), as in the diagram to the right, in fig. 49, in which the angle of fracture *h i j* is greatly reduced, and with much saving of power; but the pulverization will in practice be as effective with this smaller angle, as with the larger *b c e*. This process now described, gives a third series of lines of cleavage, which lie across the face *a e f c*, fig. 48, of the slice, as at the lines 1, 2, 3, 4, and 5; the combination thoroughly breaking up the slice, and pulverizing it.

The reader will observe here, that the fracture in any one of the directions *b d*, *b h i*, or 1, 1, is brought about by the action

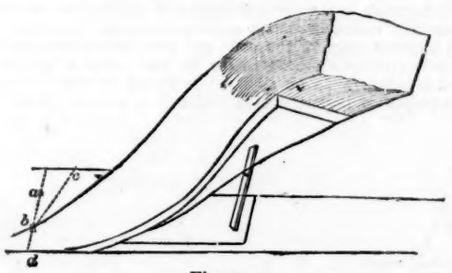


Fig. 50.

of the mould-board at only one special point; but as this point is always progressing with the forward action of the plough, a series of points of fractures will follow each other in succession, as the lines 1 1, 2 2, for example, in fig. 48. Now in the majority of ploughs as constructed with us, the curve of the mould-board or twist of the wedge which forms it, should be perfectly uniform throughout its length; so that the plane of the third line of fracture, as 3 3 in fig. 48, should depart from the plane of the second precisely as far as the second (2 2, fig. 48) does from the plane of the first (1 1, fig. 48); and that the fourth (4 4) should depart from the third (3 3) as much as the third does from the second. The reporters, and those who think with them as to the desirableness of pulverization of the soil, hold that ploughs so made are wrong, if the principles now laid down are right. No doubt a mould-board with perfectly uniform twist will take less power to drag it through the soil, but the question is, is the saving of power of greater value to the farmer, than the increase of his crops through the pulverizing of his soil? All experience seems to prove that the latter is the greatest source of gain. There should therefore in all ploughs be three points, corresponding to the three lines of direction of cleavage, as *b d*,

h i, 1 1 in fig. 48, or as in figs. 44, 47, and 49, at which the twist of the wedge or curve of the mould-board must be intensified or exaggerated, so as to ensure this pulverization; "and at these points at least the regularity of the curve must be interrupted, so as to overcome the maximum elasticity of the soil;" but this exaggeration of twist must not exceed what is absolutely necessary to accomplish the fractures, as all excess will be a loss of power.

The reporters endeavoured to measure the extent of the elasticity of soil which we have alluded to above. To do this, they inserted two wedges, *a* and *b*, fig. 50, at right angles to the land side of the furrow, when the plough, set to cut a depth of slice

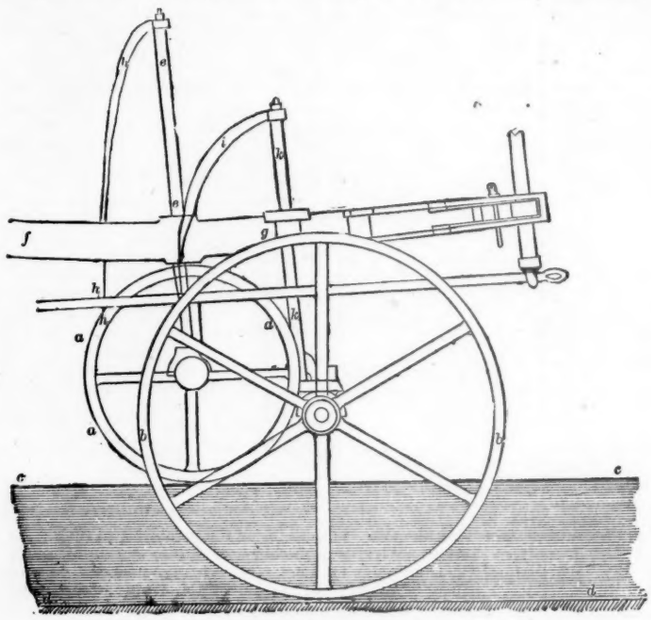


Fig. 51.

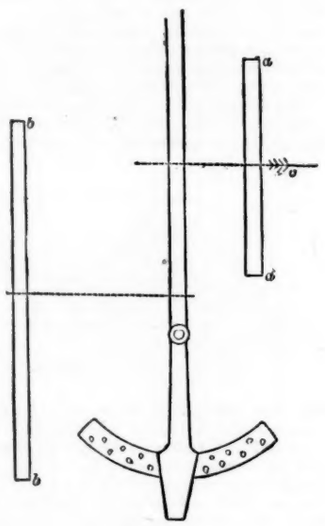


Fig. 52.

a foot deep, came up to them at the "zero" point (see paper in No. 5 of this journal for explanation of this term); the wedges ceased to be at right angles, but were drawn so as to form an acute angle with the land side, the point *b* being in advance of the point *c* no less than seven inches.

Having thus in the present paper and towards the conclusion of our last, endeavoured to explain the advantages derivable from a pulverization of the soil, and the principles upon which that pulverization depends so far as the action of the mould-board is concerned, we shall be prepared to consider further some points of importance in connection with it. But before

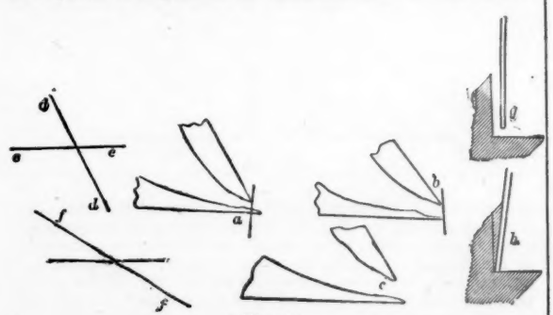


Fig. 53.

entering upon this part of our enquiry, it will be as well to describe those parts of the plough which have not yet been noticed, as some of the points connected with these have a bearing upon the question above alluded to, and will help us the better to understand it.

In fig. 15, p. 362, in vol. i. of this journal, we gave an illustration of the simplest form of plough in use in this country, this being known as the "swing plough." The other class of plough is the "wheel," the parts of which are nearly the same as in the swing, with the exception of the wheels. These, as shown in elevation in fig. 51, are connected to the plough at one end of the beam nearest the horses. The arrangement figured is that of one of the best-known ploughs of English make. There are two wheels of unequal diameter, and one in advance of the other, as shown in fig. 52. The smaller, or "land wheel," *a a*, figs. 51 and 52, is so-called because it runs on the unploughed land, the level of which is at *c c* in fig. 51. The larger, or furrow wheel, *b b* runs in the bottom of the furrow, the line of which is at *d d*, fig. 51. The difference of levels between the lines *c c*, *d d* is the depth of the furrow slice. The wheels *a a*,

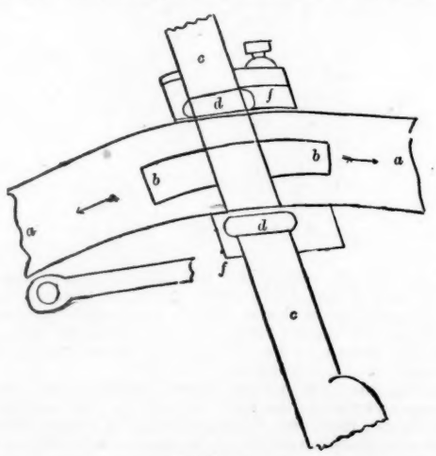


Fig. 54.

b b are adjustable as regards the relative depths at which they run, the land wheel having only a vertical adjustment; but the "furrow wheel," *a a*, has two adjustments, one vertical to correspond with the vertical adjustment of the land wheel, one lateral in the direction of the arrow, *c*, fig. 52, this being given to it in order that it may accommodate itself to the breadth of the furrow slice which it is desired to take. This lateral or horizontal adjustment is regulated by moving the square axle of the wheel in and out in its square bush, which terminates the

stem *e e*, which carries the bush at its lower extremity, and which stem is secured to the beam *f*, by a looped screw *g*, bolt and nut. The two wheels are each provided with "scrapers" *h h*, *i i* which are curved pieces of iron attached to the upper

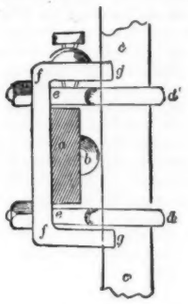


Fig. 55.

end of the stems *e e*, *k k* of the wheels, and coming in contact with the wheels at the points *h* and *i* as shown, finished off with a sharpish chisel point, they serve to keep the peripheries of the wheels free from earth, &c.

The "wheel" question was at one time most fiercely, at all events most keenly, debated by those who advocated the use of the "wheel plough" as superior in practical working, and those who advocated the use of the "swing plough" for the same reason. But it is now almost withdrawn from the field of

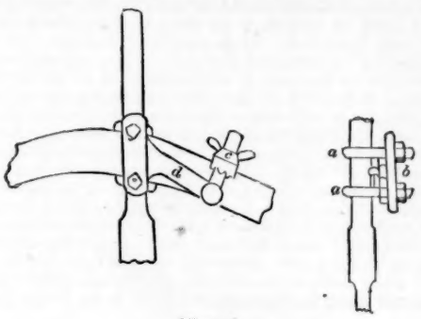


Fig. 56.

agricultural controversy, inasmuch as although the two classes of practicians may not be convinced of the error of their respective opinions, a tacit truce is now maintained, the swing plough still holding its own in districts where it has always been the favourite, notwithstanding the preponderance of

Fig. 57.

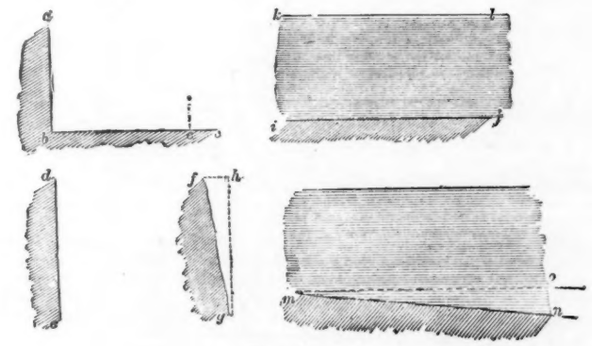


Fig. 58.

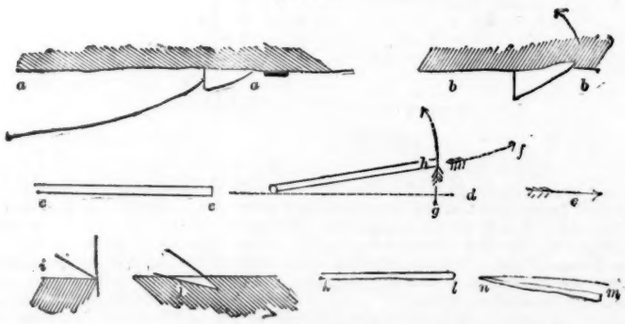


Fig. 59.

opinion in favour of the wheel plough. Taking a dispassionate view, indeed, of the whole question, which we can do better now that the "warmth of the day" has gone down than when it waxed fiercely, it seems to be pretty well established that in the case of soils of nearly the same character, the wheel plough is easier to work, requires less exertion on the part of the ploughman, and gives with great facility the means of regulating the depth of the furrow slice, so that uniformity in depth can be secured with certainty. Now, if the wheel plough gave no other advantage than this last, it would be of immense value, inasmuch as uniformity in the depth of the furrow slice is not obtainable with anything like ease of working by means of the swing plough. At the same time it must, on the other hand, be admitted that there are certain classes of soil, such as those which are rough and abound in stones, small boulders, and the like, in which the swing plough has the advantage over the wheel.

The next part of the plough to which we direct attention is the "coulter," the office of which is to cut the slice vertically from the land sides. A good deal of discussion has been given to the point as to which is the best position in which to fix this member to the beam of the plough; that is the line of rake or angle which the edge of the coulter makes with the surface of the land, and the relation which the flat side of the coulter has to the land side of the furrow slice; the third point is one which is always easily determined, namely, that the part of the beam to which it is to be fixed is that which will allow the point of the coulter to be a little above the point of the share but a little back from it, as at *a* fig. 53, others keep the points of the share and the coulter coincident, as at *b*; some set the coulter so that it be

near the surface of the share, as at *a*, some that it be at some distance from it, as *c*. Then, again, as to the rake or angle at which the coulter is set, some prefer the iow rake, as at *d*, fig. 53 (*e e* being the line of beam), some a greater rake, as at *f f*. Then, again, with relation to the land side, some set the coulter that it shall be parallel to it, as at *g*, some that it forms an angle with it, as at *h*. Each ploughman has his own way of adjusting the coulter; and although contrary to what might be supposed to be the case, it matters little so far as the rake is concerned, how great or little that may be, for the set or rake exercises little or no influence upon the draught of the plough, in clean soils. But with weedy or foul land, or where there are long stubbles, the rake of the coulter must influence the draught, for it is clear that the weeds, &c., will clear themselves more quickly from the coulter set as at *f f*, than when it is set as at *d d*. There is, in point of fact, much diversity of opinion as to the setting of the coulter, and its influence upon the draught and the form of the furrow slice; and experiments in connection with the various points which have been opened up and which are yet unsettled, require to be made before anything definite can be known. The methods of fixing the coulter to the beam of the plough are very numerous; each maker, having his own peculiar views as to the setting, &c., has, of course, his own method of adjustment. In figs. 54 and 56, we illustrate the methods adopted by two well-known makers in England. In fig. 54, *a a* is the beam, provided on the land side with a curved snug, *b b*, projecting semi-circular in section, as at *b*, in fig. 55, from the surface of the beam. Against this the stem *c c* of the coulter rests, and is brought forcibly in contact with it by means of the looped clips *d d*. The stem *c* passes through the rings, or hoops, of these; and the stem *c*, or stalk *e e*, of the looped clips, passes through a coupling plate *f f*, and is secured by nuts as shown. The ends *g g* of the plate *f f* are notched or curved, so that part of the stem of the coulter lies in them. The length of the snug *b b* admits of an adjustment along it of the clips *d d*, and with them the coulter, so that its angle or rake is altered as desired; the range of movement along the beam, in the direction of either of the arrows, is five inches.

The adjustment of the coulter in fig. 56 is somewhat peculiar; the coulter is made with two cutting edges, and in place of the stem forming a solid part of the coulter, it is made separate and hollow, as shown at *a a* in fig. 57, this hollow stem being secured

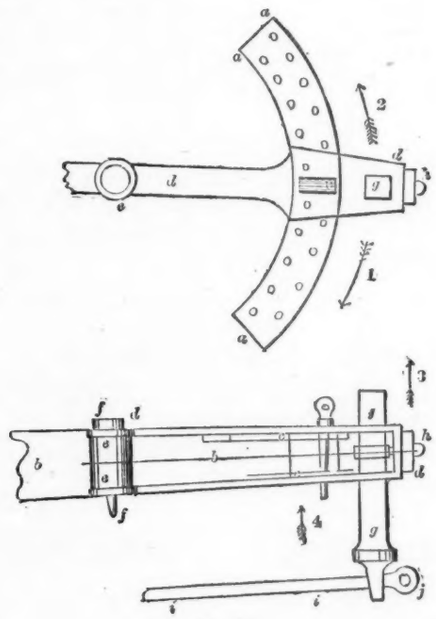


Fig. 62.

Fig. 61.

to the beam by two clips *a a*, fig. 56, and a plate *b*. A rod *b*, fig. 57, passes up the tubular stem *a a*, and is secured by a screw nut as shown. The lower part of the rod enters into the upper end *c* of the coulter *d d*. By this arrangement an old worn-out coulter can be taken out and a new one adjusted in the stem. The rake is adjusted by the thumb-screw *c*, fig. 56, acting on the lever *d*, connected with the coulter clips.

Having explained the general features of the "wheel" and the "coulter," and the mode of adjustment of these to the beam of the plough, we now take up the other parts remaining to be noticed, as the "head" or "bridle," and the "share." The "head" or "bridle" is that part of the plough which is placed first in advance of all, and to which is attached the drag, bolt, and chain by which the horses are attached to the implement. This part of the plough is not rigid, but is capable of adjustment, so that by means of it the acting parts may be given more or less of "earth" or of "landing," as in the judgment of the ploughman may be required in actual working. If the reader will refer to the second of our articles upon the plough, he will have there explained in a general way the meaning of the terms "earthing" and "landing;" but it will be necessary here to go more fully into the matter, as much of what we now say refers to the "share" as well as to the "bridle" of the plough, and which will be illustrated by the following rough sketches:—In fig. 58 the line *a b* represents the "land side" of the part cut out by the action of the plough, the void space being the part which has been occupied by the rectangular block of soil cut out, and which is called the furrow slice; the side *b c* is the "sole" or "earth side" of the slice or space occupied by the slice. If the plough is so adjusted that neither the share nor the coulter cut into the land, the land side *a b* (which is in vertical section) shows in plan at *d e* a parallel line, which we may call the "normal line of landing;" but if it is adjusted so that the share or coulter cut into the land as at the line *f g*, the plough is said to have "landing" given to it, the amount of which is obviously equal to the extent (as *f h*) to which the line *f g* deviates from the line *g h* parallel with the normal line *d e*. Again, if the plough is adjusted so that the share cuts the soil horizontally at the bottom of the slice, so that the earth or sole line *i j* is parallel or nearly so with the surface line *k l* of land, the line *i j* may be called the "normal line of earthing;" but if the plough be so adjusted that the share cuts into the soil at the earth line or sole line, as at *m n*, the plough is said to have had so much "earthing" given to it, an amount of which is equal to the extent (as *n o*) of deviation of the line *m n* from the normal line *m o*. In fig. 59 these positions with relation to the plough-beam are roughly sketched out. Thus, at *a a* the plough is so adjusted that it has taken no "landing." At *b b* it has "landing," and these adjustments will obviously be dependent upon the position which the beam *c c* (in plan as being looked down upon) has to the "normal" line *c c d*; if adjusted so that the plough in place

of going in the direction of the arrow *e*, is going in the direction of the arrow *f*, the amount of "landing" will be measured by the distance *g h*. Again, at *i* the plough is so adjusted that it has no "earthing;" at *j* it has "earthing," and these adjustments again will depend upon the position which is given to the plough-beam *k l* (in elevation as looking at it from the side) and its relation to the "normal line of earthing," as *k l m*; the extent of "earthing" being measured by the degree to which the beam, as *n m*, dips below the normal line, *n m*. We shall see—indeed, in the second of our papers we have to some extent shown it—as we proceed, that by special adjustments both the share and the coulter, each independently of the other or both in conjunction, may be made to take more or less "earth" or "land," as required; but the same adjustments are also effected by the "head" or "bridle," and on the principle indicated in fig. 59, and more elaborately illustrated in fig. 60, which is the drawing in plan and elevation of this part of the plough, as exemplified in "Small's" or the Scotch Swing Plough. The outer end—next the horses—of the beam is shown at *a a* in elevation, and *a' a'* in plan. This is embraced at its outer extremity by the "cross head," *b b*, in elevation, and *b' b'* in plan. This is jointed to the beam *a a a' a'* at the joint *c c'*; and on this joint the outer and inner ends of the bridle can be made to sweep through arcs of circles (of which *c b* is the centre), indicated by the arrows 1, 2, 3, 4. Any degree of sweep of the outer end, to which the shackle bolt *f* and hook *g*, and to the latter the draught chain is attached, can be secured within certain limits by giving to the inner end of the bridle the curved head *d d*, which can be secured by means of a pin *c c' c'* passing through holes in the curved part *d*, and a hole in the beam *a a*. As the outer end, with its shackle bolt and hook, *g* and *f*, is lowered in the direction of the arrow 3, and the part *d* raised in

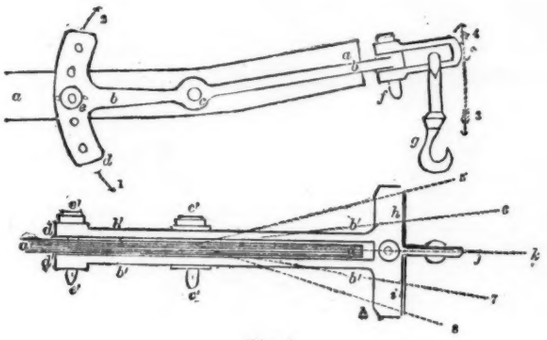


Fig. 60.

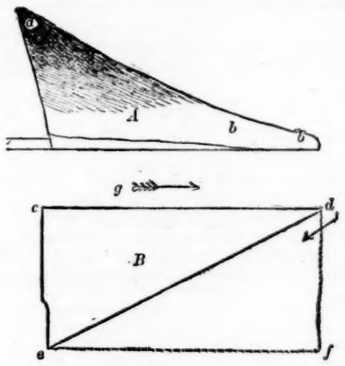


Fig. 63.

that of the arrow 2, the ploughshare has more or less "earthing" given to it. The outer end of the bridle, and to which the shackle bolt *f* is attached, is provided with a head *h h* (in plan), provided with a series of holes *i*, the shackle *f* (in elevation) is secured to any one of the holes *i i* (in plan) by the bolt and pin, as shown in elevation, and according as the shackle (and by consequence the hook *g* and attached draught chain) is fixed in these holes *i i*, to right or left of the normal line *j k* (in plan), as indicated by the arrow, the plough has more (arrows 5 6) or less (arrows 7 8) "landing" given to it. In fig. 61 we give the plan of the "bridle," of which the reader will find elevation in fig. 15 (at *c c*), p. 362, part v. for May, 1873, of this magazine. In fig. 62 we give the "head," or "bridle," of one of the most celebrated wheel ploughs of English make; in this the "landing" is given by the segmentally ended plates, *a a* in plan, which are secured to, or are made to form part of, the beam *b b* (in elevation, lower diagram in fig. 62). These plates are both above and below the beam, as at *c c* (in elevation), and the bridle is a double-linked strap, *d d*, jointed to the beam by the eyes *e e*, and secured by the pin *f f*; by moving this strap in the

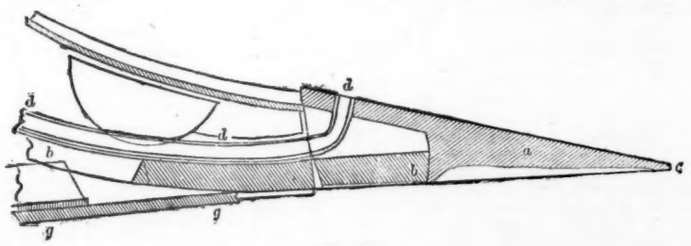


Fig. 64.

direction of the arrows 1 and 2 (in plan), the plough can be made to take less (arrow 1) or more (arrow 2) "landing" as required. The "earthing" is adjusted by having a bolt *g g*, in elevation (*g'* in the plan,) passing through an aperture in the end of the strap *d d*, and which is secured by the screw bolt *k* in any desired position. The lower end of the bolt or bar *g g*, carries the draught rod *i i* to the eye *j* of which the shackle and hook is attached, and by which the draught chain is connected with the plough. By raising the bar or bolt *g g* in the direction of the arrow (3), or lowering it, as in 4, the plough can be adjusted to give more (arrow 3) or less landing (arrow 4).

We now come to the consideration of the "share," which, as formerly described, has for its office the cutting of the furrow slice horizontally, that is from the line of sole *b c*, fig 58. In fig. 63, A is a rough sketch of a share in elevation; B in plan. As seen in elevation (A), the upper part *a* is curved, and dies away, so to say, into the curve of the mould-board, of which, to an unpractised eye, the share forms a part; and it is only at the front, *b b*, that the share flattens out to be in some degree parallel with the sole line *b c*, fig. 58. While one side, the "land side" of the share, as *c d*, is parallel with the land side, the furrow side *e d* runs off at an angle, forming a tapering point *d*. This line *e d* is called the "feather" or "feather-edge" of the share, and exercises an important influence on its working capability, for if the share was made "spud-like," that is with its front edge *d f* at right angles to the line of draught, as indicated by the arrow *g*, the draught of the plough or its resistance to the dragging force would be greatly increased; the tendency of the share with its flat side, *d f*, would be to force from *d* obstructions in the soil, such as stones, hard soil and the like, whereas by making the line *d c* at an angle, these slide up this angular side, so to say, in an easy way, as shown by the arrow at *d*. The "share" or "sock" does not completely cut away horizontally the furrow slice from the soil, but leaves a portion uncut; this portion so uncut serves the purpose of a fulcrum, so to speak, for the action of the mould-board, which as it is dragged forward tears asunder the part which the share left uncut. Were the slice wholly severed from the sole line by the share, the mould-board would have some difficulty in turning the furrow slice over at the required angle. As the tendency, then, of the slice would be to slide away

from the share, in figs. 64 to 67, we give various views of the share and method of its adjustment in the same well-known plough, of which in fig. 62 we have given illustrations of the bridle or head. The front part of the frame is rounded as at *a a*, fig. 66, and is hollowed out to receive a wrought-iron bar, *b b*, figs. 64 and 65, termed a "lever-neck;" to the extremity of this is attached the share, *a*, as shown also in fig. 66, which shows the manner in which the lever-neck or bar *b*, hooks on to or bears upon the rounded front of the frame *a a* of the plough. The other extremity of the lever-neck is provided with two curved projections which fit into notches *c d*, in the back part of the body of the plough, as shown in fig. 65. The lever-neck *b b*, figs. 64 and 65, extends upwards at an angle to the line of the sole; and at its upper extremity passes through the slot in a curved bracket, which is bolted

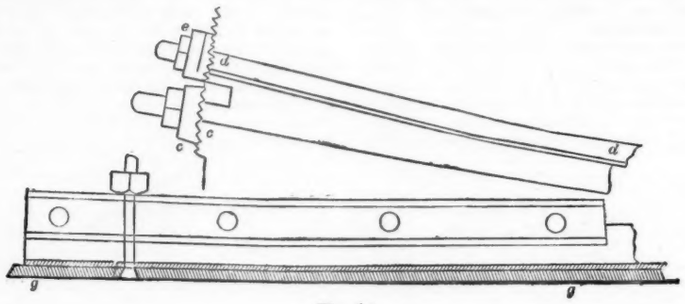


Fig. 65.

on to the body, and lies horizontally. A washer, *c*, fig. 65, is also provided, through which the end of the lever-neck *b b* passes, the inner side of this being formed with corresponding indentations to fit into the projections on the body as shown, the two being brought close and secured together by the nut, as in the drawing. By adjusting this nut, and shifting the position of the line of the lever-neck *b b*, the point *c*, fig. 64, of the share can be raised or lowered as desired, thus giving it more or less "earth." Parallel to, but placed above, the lever-neck *b b* is another rod of smaller diameter, *d d*, this is termed the "share-hook," and the lower end (see fig. 64) is turned up and hooks into a hole formed in the share to receive it; the other end (see fig. 65) is provided

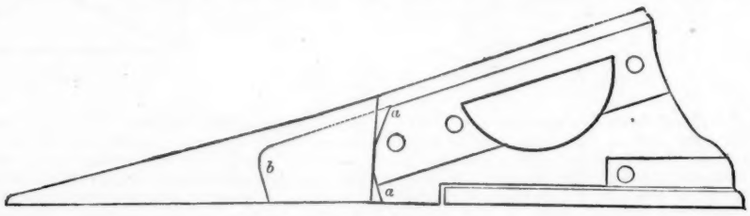


Fig. 66.

with a nut *e*, by tightening which the share is secured firmly to its seat in the end of the lever-neck *b b*. Fig. 67 is a plan of the share and lever-neck of which fig. 64 is an elevation.

In concluding our general description of the plough in its principal varieties, we think it necessary here to allude to the recent impetus which the question of steam culture has given to investigations into the fitness of the plough for the kind of work which our various systems of cultivation required. A vast variety of arguments have been produced pro and con, some looking upon the time-honoured plough as in every respect the instrument required, and view with scorn or indifference all attempts to substitute other forms of cultivation for it. Others, again, deem a com-

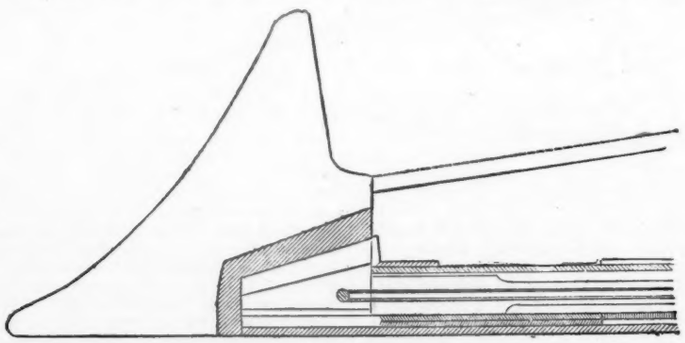


Fig. 67.

plete revolution necessary in our mode of breaking up the land, and propose to introduce a totally new class of machines, by which the "pulverizing" of the soil may be more quickly and economically effected than by the plough. Those there are again —and this is perhaps the most numerous class—who take the middle point between these two extremes, and while by no means setting their faces against the substitution of a new class of machines which can do the work allotted them, still are of opinion that, for many years at least, the plough will be *the* instrument principally used, and therefore deem it the wisest course to thoroughly investigate the principle of the plough, with a view to make its operation as perfect as this principle will admit of, and while with the first class we have alluded to honouring and valuing "the plough," they are not, like them, blind to its admitted defects. What these defects are, we now purpose briefly to show.

Referring to the illustration in fig. 58, the reader will perceive that the passage of the sole of the plough tends to form a crust or hardened surface in the bottom of the furrow, that however well pulverized the parts of the soil above this may be, this line *b c* in fig. 58, or *b c*, fig. 68, forms the line of demarcation between the parts operated upon and those never coming under

the disturbing influence of the active parts of the plough—for the oftener the land is ploughed at a uniform depth, the harder does this surface become. Three evils may thus be brought into action—increase of draught of the plough in succeeding workings; the formation of chambers, as *a*, fig. 68, in which surface-water may collect; and lastly, the formation of a hard crust, indicated by the line *b c*, through which the roots of plants cannot easily penetrate, tending to confine their growth to the comparatively small depth of the furrow-slice. Now these three evils are inherent in the action of every plough, and of these the opponents of the implement give the last as that productive of the greatest loss to the agriculturist. The operation of the plough in this way, it is argued, is practically a limitation of the seed bed, and of the consequent productiveness of the soil. We may certainly increase the depth to which the plough may work, but with increase of depth we increase in an amazingly quicker ratio the increase of difficulty in working, with the consequent cost of labour. Experience and theory alike seem to show that the deeper we have our pulverized soil the better, and that it is difficult to point out the limit beyond which we should not stir the soil. Indeed, should opinions respecting the utility of deepening the seed-bed spread widely, and result in demonstrating beyond gainsay that larger returns are obtainable from deep than shallow culture, which seems, to our mind indeed, a settled fact, it is difficult to see how the plough, without some modification of its present form, can long maintain its high position. Certain it is, that the stirring or raising up of the soil to a depth of five or six inches only, as is generally practised with horse-ploughing, cannot long be maintained as giving good work.

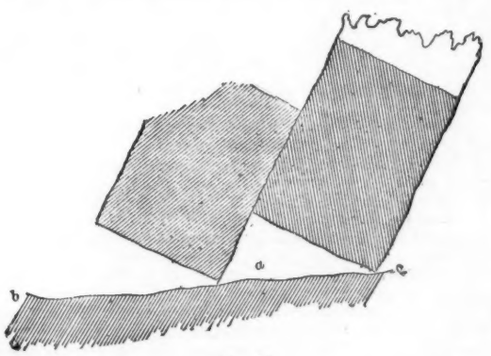


Fig. 68.

It is a simple scratching or scoring of the surface, but little removed from the elementary idea of ploughing, and altogether unworthy of modern cultivation. It is just in view, indeed, of the importance of a deep seed-bed, that the discussion about the fitness of the plough has arisen; for however fully the work is done by it, and however essential to good cultivation its features might be supposed to be, there is a limit beyond which it cannot be worked with profit by horse-labour; for the difficulty of working it increases in a much higher ratio than the depth. Hence it is, that even with those who accept the plough as the instrument best calculated to secure good cultivation, the necessity has made itself apparent, that to enable it to stir the soil to a greater depth, much must be done in the modification of its form and details; the improvements desiderated by these modifications being the lessening of the draught and the prevention of the hard crust or sole in the bottom of the furrow, and the pulverization of the soil. The first of these improvements has as yet only been attempted to be attained by modifying the form of the mould-board, so that it will transmit the slice to its final position with the minimum expenditure of force. Some mould-boards effect this with such comparative ease and precision, as apparently to leave little further to be done in this direction. Rollers to the under side of the plough, and to the sole or slide, have also been proposed. The hard crust or sole is proposed to be got rid of by the use of revolving tines like those of the Norwegian harrow, following immediately upon the action of the plough, and turning up the surface upon which the sole was resting.

On the question of cultivation and the capability of the "plough" to carry out its requirements, Mr. Chandos Wren Hoskyns, the well-known author of "Talpa; or, the Chronicles of a Clay Farm," and himself the inventor of a rotatory cultivating machine, has the following: "I cannot desert the principle that that particular *mode* of turning the soil peculiar to the plough is the mere relative necessity of a particular tool, that it may be done, and is done, in other ways, and that it will be done with less expenditure and waste of power in detail, beginning from the top, as a planing machine would cut through a board, than by upheaving the furrow-slide from the bottom upon the hardened fulcrum of a subsoil already too compact and impervious, and lastly, that by so performing it in detail, the object of *cultivation* supplementary to that of inversion with the plough is undoubtedly comprehended in one operation, a confirmation, to my mind, on the principle of occult relations of mechanical truth, that the suggestion is a right one."

We have not yet done with the suggestive points here only briefly alluded to.

Chemistry applied to Arts and Manufactures; Engineering; Building, &c.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF SOCIETIES, ETC.

§ I. *Acids, Alkalies, and Salts.*

GAS-RETORT Carbon in Sulphuric Acid Manufacture.—The distillation of sulphuric acid in glass retorts is always a dangerous operation. Even with lateral heating, and the insertion of platina wires, sudden subversions sometimes occur with force sufficient to break the neck of the retort or drive out the bottom of the receiver. RAOULT avoids these dangers, and obtains a perfectly uniform rate of ebullition by placing a few fragments of *gas-retort carbon* in the acid. The fumes are condensed in the ordinary way, and the distillation proceeds very rapidly. The fragments of carbon should be as compact as possible; they are scarcely affected by the acid, and will serve for many successive distillations. The only impurity in the distilled product is about 25 cubic centimetres per litre of sulphurous acid, which may be got rid of by a current of dry air—of this, however, there is usually no need. *Les Mondes*, 10*th Dec.* 1874. *Comptes rendus*, *lxxix.* 22.

New Method of preparing Sulphate of Soda.—At St. Gobain a new method is employed in the manufacture of sulphate of soda, by which bye-products of some value, such as the silicates and carbonates of soda, sulphuret of soda, sulphur, &c., are obtained at the same time, and under very advantageous conditions. It changes the whole system of manufacture of the salts of caustic soda and glass, by substituting the silicate for the sulphate of soda, and allowing the sulphurous principle of the latter, which hitherto has been lost, to be collected and utilized. The process is based on the discovery that sulphate of soda with charcoal and silex produce a silicate of soda, and, by sublimation, sulphur, sulphuric acid, and carbonic oxide. The process is carried on in a retort, similar to those used in gas manufacture, and heated in the same way. The sulphur is collected by simple condensation. The sulphurous acid may be transformed directly into sulphuric acid, or may be absorbed by carbonate of soda, producing bisulphuret of the same, which treated with zinc gives a hydrosulphuret of soda, now used in preparing solutions of indigo. Silicate of soda, which is the chief product, may be advantageously employed in glass manufacture. Soda is obtained from it either by decomposing the carbonic acid or by treating with lime. *Moniteur Indust. Belge*, 1*st Dec.* 1874. *Les Mondes*, 3*rd Dec.* 1874.

Fluorides in Glass Manufacture.—In America *cryolith* is employed in the manufacture of an opaque white glass. The mixture is composed of 9 parts by weight of zinc white, 4 of cryolith, and 10 of quartzose sand fused in an ordinary crucible, which is not injured thereby. During fusion there is a constant disengagement of fluoride of silicium, but not in quantity sufficient in anywise to affect the manufacture. The glass thus obtained is of a milky white, lustrous, very hard, and resists perfectly the action of acids, even when exposed thereto as a powder.

HAGEMANN and JÖRGENSEN find its composition to be as hereunder:—

Oxide of zinc	6·50
Silicic acid	63·40
Alumina	3·67

Soda	5·85
Oxide of iron and manganese	4·40
Cryolith	15·14

A certain proportion of fluoride thus remains undecomposed, to which the glass owes its hardness and refractive power.

For bottle-glass a fusible spar is formed of the residue of the cryolith, with chalk in place of soda and alumina. This fusible spar is added to increase the fusibility of the glass, but in reality it improves it generally. The spar has the following composition :—

Chloride of lime	62·01
Carbonate of lime	11·89
Lime	5·62
Carbonate of potash	0·37
Carbonate of soda	3·94
Magnesia	0·93
Silex	3·78
Oxide of iron	5·00
Alumina	5·00
Water	1·45

From 9 to 20 per cent. of spar is added. A bottle-glass containing 9 per cent. of spar shows the following composition :—

Potash	2·85
Soda	6·99
Lime	15·40
Magnesia	1·08
Alumina	11·00
Oxide of manganese	2·79
Oxide of iron	3·60
Fluor	1·75
Silex	55·20

Bulletin de la Soc. Chim. xxii. 12, *from Dingler's Polytech. Jour. ccxiii.*

New Industrial Application of Chloride of Zinc.—MERITENS and KRESSER propose to employ this chloride in tanning. The skins are steeped for twenty-four hours in a chloride of zinc bath, containing one-tenth part of chloride; they are afterwards washed in a solution of soap, and dried.

The readiness with which chloride of zinc acts upon gelatine suggests its use in sizing paper, which would thus be rendered less hygrometric and liable to decay.

It might also be advantageously employed in preparing gelatine for photographic purposes. The very best gelatine is not wholly free of grease, which causes the ink to run, and produces a blurred effect. This might be obviated by dissolving the gelatine in a solution containing one-tenth part of chloride of zinc, and after impression, passing the proofs through a bath of the same solution of like strength. *Les Mondes*, 3*rd Dec.* 1874.

Glycerine a Remedy for Incrustation in Boilers.—ASSELIN (Société des Ingénieurs Civils) advocates the use of glycerine in boilers. Its reactions with the salts of lime are imperfectly understood at present; but it is known that it raises the curve of solubility of these salts, and more particularly of sulphate of lime, and under certain conditions forms with them *soluble* compounds. When glycerine is added to water containing an excess of these salts, they are precipitated in a gelatinous form—in the form best adapted to prevent incrustation. With glycerine we have no double decomposition, no granular or pulverulent precipitates. The phases of its action are three :—1. It increases the solubility of the sulphate of lime. 2. It forms therewith a soluble compound. 3. The latter becomes precipitated. About 1 kilog. of glycerine may be allowed to every 3,000 or 4,000 kilogs. of fuel. The rule, however, is not inflexible, but must be varied with the water and the nature of the fuel. The glycerine should be commercially, if not chemically, free of lime. It is recommended to add it beforehand, and in the requisite proportion, to water sufficient for a fortnight or a month's consumption. At the present price of the article, 1·20 francs to 1·25 francs per kilog., the average cost would be about 25 centimes per ton of fuel burned. The glycerine, being mixed with the feed-water beforehand, will have time to act on the lime, and as it forms a soluble, and not an insoluble soap, it is assumed that its action in the boiler will differ from that of fatty matters generally, and entail no risk of *priming*, &c. *Moniteur Indust. Belge*, 1*st Dec.* 1874.

Soap Manufacture.—PERSOZ patents a process for the manufacture of lubricants out of various substances of minimum value, such as refuse oils, liquid waste of petroleum, gas-tars, schist-oils, &c. He dissolves fats, fatty-acids, or resins in one of these oils, or a mixture of them, adding alkali, or a caustic alkaline solution, with heat if required. Preference is given to oleic acid, which is obtained commercially in the manufacture of stearic acid, and is mixed with soda or lime dissolved in water. Oleate of lime has the property of melting at a very moderate temperature, so that in contact with the bearing-surfaces of machinery in motion it behaves like lubricants commonly so called. Oleate of soda does not possess this property; by substituting one for the other the fusibility of the product may be varied according to the season and the object in view. The process is simple and expeditious. The fat is stirred into the oil, the diluted alkali quickly poured in, and the whole agitated until the saponification of the mass is complete, which takes place in a few moments. Part of the alkaline water is absorbed, and the rest rises to the top and can be run off. Resin increases the consistency of the product, but renders it too adhesive for general use as a lubricant. The process may be applied to the manufacture of soaps with soda or potash bases. Here the oleic acid is placed in a volatile oil and saturated with caustic alkali; the solvent is got rid of by distillation or steaming, and the soap run off into moulds. *Moniteur Indust. Belge*, 10*th Dec.* 1874.

Adulteration of Chrome.—Red and yellow chrome and orange-lead are most often adulterated with the sulphates of lime and baryta, gypsum, and chalk. To detect the presence and ascertain the proportion of these substances, WITTSTEIN recommends the following methods :—

Qualitative Analysis. — *a.* Into a test-glass containing 1 gramme of pigment pour 7 grammes hydrochloric acid (sp. gr. 1·12). Effervescence indicates the presence of chalk.

b. Heat until a levaceous white precipitate forms. Add 1 gramme of alcohol of 90° C.; heat until the yellow of the solution changes to green, *i. e.* until all the chromic acid is transformed into chloride of chrome; add 100 grammes of water; filter; collect the precipitate in the filter, wash it until it shows no further acid reaction, and no longer becomes turbid when treated with chloride of barium. The filter contains sulphate of baryta only.

c. If the filtered water reacts with sulphuric acid, oxide of lead, or oxide of lime, or both, are present.

d. Add to the filtered liquor 1 gr. sulphate of soda in crystals, agitate until the latter disappears, allow the solution to settle. The fine white precipitate formed is sulphate of lead.

e. Filter the latter; treat the filtered liquor with ammonia to precipitate the chrome, which separate; add oxalic acid to the liquor, and if it becomes turbid, lime is present.

Quantitative Analysis.—1. *Sulphate of Baryta.* Proceed as in *a* and *b*; weigh sulphate of baryta after calcination, and the loss of weight will show proportion of sulphate of lead. As a check: separate sulphate of baryta, precipitate sulphate of lead with sulphate of soda, calculate the lead present from the proportion of red precipitate. Again, separate the sulphate of lead, precipitate the oxide of chrome with ammonia, and compute the proportion of chromic acid from the amount of calcined precipitate.

2. *Sulphate of Lead.* Heat for half-an-hour in a porcelain capsule 1 gr. of pigment, 2 gr. carbonate of soda in crystals, with 50 gr. water, filling up with water as the latter evaporates. The chromic and sulphuric acids present will be taken up by the soda, leaving the lead oxide in the form of a carbonate, which speedily passes into an anhydrous oxide of a dirty brick-red colour. The alkaline liquor freed of oxide of lead is saturated with hydrochloric acid; the sulphuric acid is precipitated with chloride of barium, and from the sulphate of baryta thus obtained the sulphate of lead is computed. Deducting the weight of the latter from 1 gr. of the pigment, we get the proportion of chromate of lead contained therein.

3. *Sulphate of Lime.* Heat for about half-an-hour in a porcelain capsule 1 gr. of the pigment, 2 gr. of carbonate of soda crystals, with 50 gr. of water, filling up with water from time to time as the latter evaporates. Wash the residue until the water no longer becomes turbid with chloride of barium; dry, calcine, and weigh. The loss of weight represents the sulphate of lime, which is considered as $S O^4 Ca + 2O H^2$, as it is never employed as plaster of Paris, but in its crude state.

4. *Carbonate of Lime.* A gramme of pigment is treated with 5 gr. of hydrochloric acid (sp. gr. 1·12); the loss of weight represents the volume of carbonic acid present, from which the amount of carbonate of lime is determined.

5. *Sulphates of Baryta, Lead and Lime, and Carbonate of Lime.* Proceed as in 2, by boiling for half-an-hour, in a porcelain capsule, 1 gr. of pigment, 2 gr. of soda, 50 gr. of water, agitating and filling up with water as the latter evaporates. Filter; collect the deposit on the filter and wash thoroughly; replace it in the capsule and dissolve in acetic acid with moderate heat. In this solution, freed of a little of the sulphate of baryta (1st sulphate of baryta), precipitate the oxide of lead with sulphuretted hydrogen; collect the sulphate of lead so formed on a filter, dry at 100° C. and calculate from it amount

of oxide of lead. Precipitate the baryta with dilute sulphuric acid, and having separated the sulphate (2nd sulphate of baryta), precipitate the lime with oxalate of ammonia. The alkaline liquor, freed of the precipitates of baryta, oxide of lead, and lime, is well saturated with hydrochloric acid; as in 2, its sulphuric acid is precipitated with chloride of barium (3rd sulphate of baryta), and the chromic acids saturated with ammonia, adding chloride of barium if required. To determine the several proportions of the compounds of lime and the oxide of lead, the chromic acid obtained as chromate of baryta is combined with the oxide of lead to form Pb O + Cr O^3 (chrome yellow), or Pb O + Cr O^3 (chrome red), and the remainder of the lead with sulphuric acid as Pb O + S O^3; deducting the latter and the sulphuric acid in the 2nd sulphate of baryta from the sulphuric acid in the 3rd sulphate of baryta, we get the sulphuric acid present in the shape of hydrated sulphate of lime; lastly, deducting the amount of sulphate of lime thus ascertained from the total weight precipitated by the oxalic acid, we get the proportion of carbonate of lime.

Generally speaking, these pigments contain 1 to 3 per cent. of hygroscopic water, the proportion of which may be ascertained by heating 1 gr. of pigment to redness, so as to determine loss of weight, deducting which the small quantity of water present in the gypsum is regarded as hygroscopic water. *Technologiste, Nov.* 1874, *from Muster-Zeitung, Nos.* 34 *and* 35.

Salt Solutions—Cryohydrates.—F. GUTHRIE has communicated to the Physical Society some very important researches respecting the above, which promise to throw unexpected light on various obscure points in applied as well as natural science. He has detected certain combinations of water with salts, of which the combination of water with chloride of sodium in the proportion of ten atoms of water to one of anhydrous salt may be taken as the type, and which he proposes to term "cryohydrates." His experiments show that brines of various strengths, when mixed with water, absorb heat and expand. Water shrinks as it loses heat, till it reaches 4° C. At this point ice is formed, which, however, is dissolved in the water; a solution is thus obtained having a temperature of solidification of 0° C. (32° Fah.) At this temperature the ice and the water solidify, producing a compound body or "cryohydrate" called ice, which is, therefore, a cryohydrate of water. The expansion between 4° C. and 0° C. is due to the increasing amounts of ice held in solution by the water, such expansion being greater than the contraction of the water itself consequent on decrease of temperature.

"There can be no doubt that the discovery of an enormous number of new bodies will reward those who labour in the field of research thus opened. Taking water as the medium of solution, there appears to be no doubt that every soluble salt has a definite cryohydrate; so that in this direction alone the number of new bodies awaiting discovery and description may be estimated at half the number of bodies already known. If we vary the medium, employing say alcohols or hydrocarbonates as solvents, the number of new compounds will again be indefinitely increased, so that it is fairly within the truth to assert that the number of known bodies may soon be doubled." *Philosophical Magazine, Jan.* 1875.

Saline Matters in Snow Water.—TISSANDIER has analyzed samples of snow collected from the summits of the towers of Notre-Dame and other localities, between the 16th and 25th Dec. 1874. The samples were taken from the surface snow, where there was no direct contact with terrestrial objects. A drop of water from snow on the summit of Notre-Dame, and another from snow collected in the country on 16th Dec., each showed numerous corpuscles when viewed with a microscopic power of 500 diameters. The residua obtained by the evaporation at 100° C. of 1 litre of each water were as follows:—

	Paris.		
	In a Garden.	On Notre-Dame.	In the Country.
First snow collected on 16th Dec. 1874. . .	0·212 gr.	0·118 gr.	0·104 gr.
Snow collected on 21st Dec. 1874. . . .	0·108	0·056	0·048

The last snow collected on the 25th Dec. gave a very appreciable amount of residue both in Paris and in the country (0·016 to 0·024 gr.) The dimensions of the corpuscles were $\frac{1}{100}$ to $\frac{1}{1000}$ of a millm. The residue obtained by evaporating snow water is a grey, impalpable powder, rich in carbon, and burning brightly. The ash amounted to 57 per cent. in Paris, and 61 per cent. in country snow. It contained silica, carbonate of lime, alumina, chloride, sulphate and nitrate of ammonia, and very appreciable quantities of iron. Snow residue, from all sources alike, dissolved in pure hydrochloric acid, gives a pink colour when treated with sulphocyanide of potassium.

The presence of nitrate of ammonia may be shown by placing a drop of snow water on a slip of glass, and allowing it to evaporate in dry air; under the microscope the residue shows very remarkable crystallizations composed of nitrate of ammonia. Some of the crystals thus observed have not a rhomboidal form, and are not composed of nitrate of ammonia: some appear as well-defined cubes; these are probably chloride of sodium. Prisms with four concave faces are also sometimes seen, the nature of which is unknown. But it should be stated that when snow flakes are introduced in a super-saturated solution of sulphate of soda, the latter crystallizes at once in prisms with four concave faces. Snow, therefore, contains a notable proportion of atmospheric sediment, of various salts, and of organic substances, which must have an important share in its action on terrestrial vegetation. The occurrence of iron in aerial dust has already been observed, and these observations are confirmed by its presence in snow. Recalling Ehrenberg's discovery of microscopic aeroliths falling as fused globules, in a dust shower, on the deck of a vessel in the Indian Ocean, and the recent observations of Nordenskiöld on ferruginous aerial dust containing nickel, cobalt, and phosphorus; and recalling, too, the numerous aeroliths which constantly penetrate our atmosphere and become broken into fragments, it appears allowable to assume that amongst the corpuscles found in snow, most of which are terrestrial and lifted by aerial currents, there may be some of cosmical origin. *Comptes rendus, lxxx.* 1.

Action of Organic Substances on Nitric Acid.—MURGER, BOUSSINGAULT, and DÉHÉRAIN have shown that soils, and other organic and partly organic substances generally, are capable under some circumstances of causing free nitrogen to enter into combination with them, and of thus increasing their content of that element.

Armsby, of Yale College, U.S., communicates a series of experiments, showing that decaying organic substances, in the presence of caustic alkali, are able to fix free nitrogen without the gain being manifest as nitric acid or ammonia, and, probably, without the formation of either. *American Journal of Science and Art, Nov.* 1874.

§ 2. *Metallurgy. Mining.*

Coal in the United States.—The following useful summary of the coal measures of the United States has been prepared by Professor Hitchcock for his forthcoming "Geological Atlas of the United States." The summary includes the coal belonging to the carboniferous system only.

1. *New England Basin.*—Lies in Massachusetts and Rhode Island, and is estimated to cover 750 square miles. This coal is plumbaginous anthracite, used to advantage in some smelting furnaces. Perhaps eleven beds may exist—best seen in Portsmouth, Rhode Island. The maximum thickness is 23 ft. The whole carboniferous system is supposed to be 6,500 ft. thick, of which 2,500 ft. belong exclusively to the coal measures.

2. *Anthracite Basins in Pennsylvania.*—This is the most important coal district in the United States. There are four basins, having an area of 410 square miles, not including the Broad Top semi-anthracite, which amounts to 24 more. The measures are from 2,000 to 3,000 ft. in thickness. The number of distinct beds varies from two to twenty-five, according to the depth of the basin. The maximum amount near Pottsville is given at 207 ft., whilst the average cannot be far from 70 ft. (H. D. Rogers). Macfarlane estimates the area of the anthracite fields in Pennsylvania at 472 square miles, which is 62 more than Rogers's estimate.

3. *Appalachian Coal Field.*—This field embraces an area of 62,025 miles, extending from Pennsylvania to Alabama. In Pennsylvania, the aggregate thickness of the measures is from 825 ft. to 2,535 ft. The area of the bituminous coal is 12,222 miles, with an average thickness of 40 ft. of coal (H. D. Rogers). In Maryland the area is 550 square miles, in three separate basins. The strata are 1,500 ft. thick. There are thirty-two beds in all, one of them 14 ft. thick, three of 6 ft. each, others from 1 ft. to 5 ft. thick (P. T. Tyson).

In Virginia (chiefly West Virginia) the coal area embraces 16,000 square miles. On the Kanawha the strata are 1,250 ft. thick, with twenty-four beds of coal, of which eleven have an aggregate of 51 ft. in thickness. The coals seem best developed on this river (T. S. Ridgway).

In Ohio, Dr. J. S. Newbury states the area to be more than 10,000 square miles, with a thickness of 1,500 ft., and ten workable beds of coal corresponding in regard of thickness to those of Pennsylvania and West Virginia.

In East Kentucky the area has been stated to be 10,000 square

miles. Macfarlane puts it at 8,983 square miles, said to have been derived from actual measurement.

In Tennessee Prof. Safford states the area of the measures to be 5,100 square miles. One characteristic section gives a thickness of 14 ft. The beds vary locally in their dimensions, some of them being 9 ft. thick, but thinning out very rapidly.

In Georgia the area may be represented by 170 square miles.

In Alabama the area marked upon the map amounts to about 9,000 square miles.

4. *Michigan Basin.*—This basin has an area of 6,700 square miles, with 123 ft. of measures, and 11 ft. (maximum) of coal. In the centre the coal is thickest, thinning out to nearly the thickness of paper around the edges (A. Winchell).

5. *Illinois Basin.*—This basin, including Indiana and West Kentucky, covers an area of 47,183 square miles.

In Illinois the measures occupy 36,800 square miles, are 600 ft. thick, and contain ten beds of coal, with an aggregate thickness of 35 ft. (A. H. Worthen).

In Indiana the measures occupy an area of 6,500 square miles, are 650 ft. thick, and contain thirteen beds of coal, with an aggregate thickness of 31 ft. (E. T. Cox).

In West Kentucky the measures are 612 ft., including the millstone grit, and carry eleven beds of coal (E. T. Cox). Their area in West Kentucky is 3,800 square miles (S. S. Lyon).

6. *Missouri Basin.*—This basin extends from Iowa to Texas. Estimating, from Haydon's map, the coal area of Nebraska at 3,600 square miles, the total area of this great basin must be about 97,200 square miles.

In Iowa, Professor White's map shows an area of 18,000 square miles, divided into three parts, each 200 ft. thick. The two lower divisions contain the workable coal, which amounts to 8 ft. in the second, but is only 20 in. thick in the upper. As the higher division is everywhere underlaid by the others, the whole area must be regarded as workable.

In Missouri, Professor Swallow estimates the coal area at 27,000 miles. The measures are 2,000 ft. thick, with twenty coal beds from a few inches to 6 ft. in thickness.

In Arkansas there seem to be only two beds of coal, which lie below the coal measures proper beneath the conglomerate (Lesquereux). D. D. Owen speaks of some beds from 4 ft. to 5 ft. thick, and estimates the area occupied by productive beds at 12,000 square miles.

In the Indian territory little is known of coals. The officers of the Missouri, Kansas, and Texas Railway Company find good banks of coal, several feet thick, at several places along their line. The area upon the map amounts to as much as 13,600 square miles. Since the completion of the map it has been ascertained that the coal measures are covered by the cretaceous formation for a width of about thirty miles along the valley of the Red River in Texas and the Indian territory, and also that the tertiary area, extending south from Preston, is probably of the carboniferous age. The discoveries will enlarge, rather than diminish the size of the Missouri basin, since the two fields are probably connected beneath the cretaceous formation.

In Texas, according to A. R. Roessler in the "Almanack," the coal measures occupy 6,000 square miles. A bed of coal has been reported near Fort Belknap as 4 ft. thick.

7. *Territories.*—In Arizona, near Camp Apache, Mr. G. K. Gilbert, of the expedition under Lieut. Wheeler, reports a bed of coal belonging to the true carboniferous series. It is probable that future explorations may develop other coal areas in the territories.

In respect to other coals, we have various localities of commercial importance, especially in East Virginia and near the Union Pacific Railway. They usually belong to the cretaceous or triassic formation, and there are lignites in the tertiary formations. *American Gas-light Journal, 2nd Jan.* 1875.

Preparation of Nickel Sulphate without the use of Sulphuretted Hydrogen or Ammonia.—TERREIL proposes the following method of preparing nickel sulphate in an economical way, without the use of sulphuretted hydrogen or ammonia. Commercial nickel, which is a triple alloy of nickel, copper, and iron, with small quantities of arsenic, the proportion of the nickel varying from 40 to 90 per cent., is dissolved in aqua regia, and the solution evaporated to dryness; water is added, about five times the weight of the nickel, which re-dissolves the salts, excepting a small quantity of insoluble arseniate of iron, whose presence in the solution is of no importance. The solution is heated, and metallic iron is added in weight about equal to that of the nickel. Small nails are best, as they offer the greatest amount of surface for the deposition of the copper. They are well stirred in the liquor, and upon them the copper quickly becomes precipitated. The copper can be recovered by decanting the solution, and pounding the nails under water, when it scales off, and may be collected in the form of a metallic powder. The decanted liquor then contains iron and nickel only. The iron is peroxidized with chlorine or nitric acid. After peroxidization, the two metals are sulphatized by adding sulphuric acid of 66°, in the proportion of two parts by weight of acid to one of nickel, and evaporating to dryness. The residuum is treated with water to re-dissolve the salts of nickel and iron, some of the latter not unfrequently remaining as an insoluble sub-sulphate, which may be disregarded. The iron in the solution is then precipitated with carbonate of baryta, which separates it as a sesquioxide of iron, and forms, at the same time, an insoluble baryta sulphate, without affecting the nickel sulphate. The last traces of arsenic are precipitated with the sesquioxide of iron. The precipitation should be made gradually by heating the liquor to a point not exceeding 50° to 60° C., and adding by degrees a slight excess of carbonate of baryta. The pure nickel sulphate now remains alone in the solution, from which it is separated by filtration, crystallizing as it cools. *Bulletin de la Soc. Chim. xxiii.* 1, 1875.

"Neogene"—A New White Composite Metal.—P. H. SAUVAGE has produced a new composite metal, at once silvery, sonorous, malleable, ductile, and tenacious. It can be polished, burnished, hammered, &c., like other metals, and is applicable to the same industrial uses as metals of the "Maillechort" type, for which it may be advantageously substituted. Its silver-like aspect renders it well suited for cheap jewellery, the commoner descriptions of coinage, and other like purposes.

Its composition is as below :—

Copper	58·00
Zinc	27·00
Nickel	12·00
Tin	2·00
Alumina	0·50
Bismuth	0·50

The components are fused separately, mixed, and the whole run down together into a perfectly homogeneous mass. Nickel forms the base. The speciality of the new metal is the alloy of alumina and bismuth, which is believed to produce a more intimate union of the other components, and to render the metal susceptible of taking a good polish, and wearing well without tarnishing. *Moniteur Indust. Belge, 10th Jan.* 1875.

Armour-Plates for the Russian Navy.—The Swedish Iron Works at Motola have just finished the armour-plates for the Russian Imperial frigate, "Duke of Edinburgh," to be launched at St. Petersburg this spring. The Russian Government stipulated in the contract that the resistance of the plates should be 50 per cent. greater than the best plates hitherto manufactured. Only the best ore has been used, and unusual care has been bestowed on the fabrication. Very brilliant results are said to have been obtained. *Revue Indust. 13th Jan.* 1875.

Magnetism of Rails.—HEVL (Railway-Section Engineer, Mayence) reports that he has found the extremities of rails, which have been laid some time, are invariably transformed into powerful magnets, capable of supporting the weight of a small hand-wrench, and even heavier iron objects. The rails retain their magnetic power when taken up, but lose it gradually. The magnetism is only rendered sensible when the fish-plates are removed; it disappears as soon as they are replaced. The induction of magnetism in rails in work is, no doubt, attributable to the friction to which they are exposed, and it is not improbable that it exercises a beneficial influence in respect of the general stability of the line, and the hold of the wheels on the rails. It is possible that stronger currents may be induced during the passage of trains; in which case the fact would possess a wider practical significance. *Revue Indust. 13th Jan.* 1875.

§ 3. *Dyeing, Calico Printing, Bleaching, Tanning, Pigments, and allied subjects.*

Croissant and Bretonnière's New Dyes.—The inventors state that these dyes (*vide* "Practical Magazine," Feb. Nov. and Dec. 1874), can be applied to wool and silk equally as well as to cotton. With the two former, it is as well, in certain cases, to counteract any excess of basic tendency in the "colouring-bath," by adding thereto a few drops of mineral or organic acid, as acetic acid. *Bull. de la Soc. Indust. de Mulhouse, Oct.* 1874.

The same periodical contains the Report of a committee appointed by the Chemical Section of the Mulhouse Society, and composed of MM. Schœffer, Brandt, Scheurer, Rosenstiehl, and

Witz, of which the following is the substance: The committee chose for experiment the "sulphides" actually in use for dyeing yarns, viz. the sulphur derivatives of the extracts of Cuba wood, Campeachy wood, tartrate of soda, wheat bran, and humus of old oaks. The experiments were restricted to the dyeing and printing of calicos, and the dyes were prepared by the committee in accordance with M. Bretonnière's directions.

Dyeing. The committee found that calico steeped in one or other of these dyes colours at once, the depth of the shade depending on the concentration of the dye. A simple passage through the colouring bath is sufficient to fix the colour, and the intensity of the latter is *not* increased by prolonging the immersion. The bath may be used cold, but the best results are obtained at a temperature of 60° C. A fixing bath of potassium dichromate was employed, sometimes hot and sometimes cold, sometimes pure and sometimes mixed with other substances employed in such cases. The process was found to go on with great regularity, without any of those contingencies arising from defective bleaching or want of cleanliness, which render dyeing in monotones so precarious with the dyestuffs in ordinary use. The derivatives of the several extracts gave the results specified hereunder:

Extract of Cuba wood imparts a bright yellow to cotton, which will not bear soaping, and requires to be chromatized to fix it. Then it assumes a "leather" tint, which appears fairly durable. Extract of tartrate of soda gives a duller tint than the above. Extract of Campeachy wood, a grey with a pink cast. It was ascertained that with iron mordants it produces a black, not nearly so good, however, as that of ordinary logwood.

Extract of the humus of old oak-trees gives a yellowish grey; and those of wheat bran and sawdust a less decided grey. Extract of aloes gives a grey, which appears of considerable value.

The committee were unable to obtain any shade not already obtainable with the dye-stuffs previously in use; but they consider that the new dyes are extremely easy of application; that they possess a permanence rarely met with in vegetable colours; and have the further recommendation of being comparatively cheap.

Printing. The experiments under this head were made with the sulphur derivatives of the extracts of Campeachy wood, sawdust, wheat bran, and humus of old oaks. In one set of experiments the raw dye in solution was thickened with gum tragacanth; in another set acids were used to precipitate the colouring in the solution before use. The colouring matter was thus obtained in the form of black flakes intimately commixed with the sulphur. The precipitate was then washed with hot water and applied to the cotton after adding caustic soda. Whatever the method employed, the greater portion of the colouring-matter becomes fixed during impression. Steaming renders the fixation more complete, so that the dichromate bath is no longer necessary. The preliminary preparation of the material with mordants has no effect on the ultimate results. Precisely the same shades were obtained by printing with the raw solutions as by dyeing. Printing with the washed precipitate gives greys with a yellowish cast, as though the characteristic brown colouring-matter had been eliminated by precipitation and washing. The first method gives a greater variety of shades, but is apt to injure the rollers on account of the presence of sulphide of soda. The second method entails this increase in a lesser degree, but gives greater uniformity of hue. By combining the processes of dyeing and printing, it would be possible to produce styles of two or three shades, the fastness of which would be a special recommendation.

Conclusions. The committee found that the fastness of the new dyes and the readiness with which they can be used in *dyeing*, lead to the hope that they may come into extensive use for cheap goods. In respect of *printing*, the colours have too little variety to authorize anticipations of any very extended application. Had the committee been successful in obtaining a good *black*, their opinion on this point would have been altered. No mention is made of the reported offensive character of the process (*vide* "Practical Magazine," Jan. 1875).

In an additional note the committee remark, that it is impossible not to be struck with the analogy existing between these "sulphides," as the inventors term them, and ulmic compounds. Both result from the action of alkalies on the same substances at the same temperatures; but the presence of sulphur facilitates the process in a remarkable manner and increases the results, so that we may regard the sulphides as substitute derivatives of ulmic bodies, with which they have in common, colour, mode of formation, chemical properties, and even method of fixation; only the "sulphides" have a far greater affinity for vegetable fibre than the others, such as ulmic acid.

It may be interesting to point out that these substances are not necessarily very rich in carbon, although produced at high temperatures; ulmic acid, for example, which is brown, contains much less carbon than alizarine, which is orange, or anthraquinone, which is yellow, or anthracine, which is colourless. This may be seen by a glance at the subjoined table, showing the centesimal composition of these substances—

	Anthracene. (Colourless.)	Anthraquinone. (Yellow.)	Alizarine. (Orange.)	Ulmic Acid. (Brown or Black.)
C.	94·4	80·7	70·0	65·0
H.	5·6	3·9	3·3	4·5
O.	00·0	15·4	26·7	31·5

Scarlet Dye for Silk and Wool.—JEGHEL employs naphthaline and fuchsine simultaneously. The weaker the proportion of fuchsine the more brilliant the colour produced. A solution of napthaline in water is heated nearly to the boiling point, and a solution of fuchsine added in the proportion of about 2 per cent. The wool or silk is passed through a bath of the mixture. The solutions should not be mixed cold, as the fuchsine will then be precipitated in amorphous flakes. Neither should it be boiled too fast, or a portion only of the fuchsine will remain dissolved, the rest will be bright metallic green globules. In this state the liquor is totally unfit for dyeing, even when filtered. *Moniteur Indust. Belge*, 10*th Jan.* 1875.

Economical Black Dye.—Under the above name HAEZE recommends the following:—

Sulphate of copper	2 kilogs.
Potassium dichromate	1 „
Sulphate of zinc	2 „
Water	1,000 „

Moniteur Indust. Belge, 10*th Jan.* 1875.

Discoloration of Aniline Black by Acids.—WITZ communicates experiments with various acids, leading to the conclusion that the discoloration of aniline black in the presence of acids is due to the specific action of the acids, and not to deoxidization. *Bulletin de la Soc. Indust. de Rouen*, 1874.

Hygrometric Capacity of Aniline.—COUPIER observes that all anilines contain water, distillation being insufficient to get rid of it altogether.

Aniline will absorb considerable amounts of water, the proportion varying with the temperature.

At 16° Cent. aniline will take up 4 parts of water.
32° „ „ 6 „
65° „ „ 8 „
85° „ „ 10 „

Bulletin de la Soc. Indust. de Rouen, 1874.

Aniline Blacks.—GLANZMANN states that aniline being largely soluble in solutions of potassium dichromate, black may be obtained by boiling it in such solutions for a suitable number of hours. He describes five different black precipitates, three of them thus obtained. All vary in respect of composition and aspect, but all withstand perfectly the action of alkalies, acids, and light. The amount of black precipitate varies in each case directly with the proportion of dichromate used; 100 grammes of aniline boiled with 100 grammes of potassium dichromate in 1,000 grammes of water gave 26 grammes of dry black, containing 58 per cent. of organic black and 42 per cent. of oxides.

The same quantities of aniline and water with 200 grammes of dichromate gave 47 grammes of dry black, containing 57 per cent. of organic black, and 43 per cent. of oxides.

The same quantities of aniline and water, with 400 grammes of dichromate, gave 84 grammes of dry black, containing 53 per cent. of black and 47 per cent. of oxides. These precipitates require albumen to fix them, which would render their practical application very costly, and entail, besides, difficulties in the way of printing. But, without providing a remedy for the discoloration of ordinary aniline blacks, they show that aniline can be made to yield a perfectly fast black, capable of resisting the action of light, of acids, and of alkalies. *Bulletin de la Soc. Indust. de Rouen*, 1874.

Manufacture of Aniline.—The chief manufactories of aniline are now at Offenbach, Bieberich, Hochst, Mannheim, Barmen, Elberfeldt, Crefeldt, and Tournay. Together with minor establishments dotted over the length and breadth of Germany, they produce fully one-half of all the aniline manufactured in Europe, the value of which was estimated at 10,000,000 francs in 1862, 29,000,000 francs in 1867, and 38,000,000 francs in 1872. Viewed in relation to the market value of the article, the produce of 1872 was forty-fold that of 1862. In France, the

manufacture is falling off at the rate of 500 kilog. per diem in consequence of the limitation of the patent. In Germany the quantity manufactured in 1862 was 5,000 quintals only, now it is 12,500 quintals, and 5,000 more are imported to meet the demands of the home market. Some German manufacturers turn out 5 quintals of fuchsine daily, and they are beginning to manufacture aniline violet, which heretofore has been manufactured exclusively in France. Two Belgian manufacturers, one at Molenbeck, near Brussels, and the other at Tournay, also prepare very large quantities of these dyes. *Moniteur Indust. Belge, 20th Dec.* 1874.

Madder Colours.—ROSENSTIEHL observes that alizarine, when pure, furnishes fine violet dyes, but its purple reds are dull. Alone it is incapable of producing red or garance pink. It requires the aid of purpurine and its hydrate, which give orange reds. To obtain the full effect, an aqueous solution of carbonate of lime must be added, in quantity sufficient to form a monocalcic lac of the alizarine and purpurine. A stronger dose would precipitate the colouring matters in an insoluble state. Pseudo-purpurine dyes in pure water only; its colours bear neither brightening nor exposure to the light. Certain facts long since known to practical dyers may thus be readily explained. Alsatian madder will not give durable colours without chalk, as the pseudo-purpurine then acts as the dye; on the other hand, in the presence of lime it is precipitated, and then the purpurine and alizarine only are fixed, producing colours which rival in brilliancy and durability the famous madders of Avignon. The residuum of the dye-stuff contains the whole of the pseudo-purpurine, which by treating with acid is transformed into purpurine; in the same way, in the manufacture of madder and its extracts, pseudo-purpurine is transformed into purpurine and hydrated purpurine, which remain intermixed with the alizarine. Heat destroys the purpurine more readily than the alizarine, which remains by itself and produces fine violets, such as *pink-offine*. An aqueous solution of bicarbonate of soda dissolves ten times as much purpurine as alizarine; it may be used to effect an approximate separation. If to a mixture of purpurine and alizarine be added an excess of solution of carbonate of lime, the excess precipitates the purpurine; the alizarine remains, which explains why madder will give very fine violet shades in the presence of chalk; but there is a loss of colouring matter. To get the best results in dyeing, 50 parts of carbonate of lime are required to 240 of alizarine, or 256 of purpurine. If the dye-stuff contains 0·250 grammes of colouring matter to the litre, 0·050 grammes of carbonate of lime will be required. Repeated analysis has shown that the water of the Doller contains 0·053 to 0·057 grammes of lime per litre. It is therefore admirably suited to produce fine colours. *Bulletin de la Soc. Indust. de Mulhouse, Oct.* 1874.

New Mordant.—DELOBEL recommends the following:—In an earthenware jar, or other vessel, mix:

Bleaching liquor .	50 litres.
Table salt . .	12 kilog. 500 grammes.

Agitate until the salt is dissolved, then add:

Gelatine . . .	1 kilog. 250 grammes.

Cork the jar, agitate for eight hours, allow the contents to settle, and run off the clear liquor, which is the mordant designated by the inventors, "mordant des chlorures neutralisés." *Moniteur Indust. Belge, 1st Dec.* 1874.

Manufacture of Gelatine.—UYTTERHAEGEN boils down together 3 kilogs. of beef bones, 6 litres water, 5 grammes rock-salt, and 2 grammes alum, to a litre of liquor, which when cooled is suitable for sizing yarns, cotton, hempen, and silken goods, &c. *Moniteur Indust. Belge, 10th Dec.* 1874.

Tanning without Acid.—The inventor, B. PICARD, thus describes a new method of tanning without the aid of acid. A suitable quantity of tan, or of substances to serve as such, is boiled in water, and the resulting decoction is run off, so as to separate it from the sediment and from other extraneous matters. The strength of the tan can be proportioned to the thickness, quality, and description of the skins, being reduced, when requisite, by the addition of pure water. This essence of tan, of a suitable strength, is poured cold into the pits, into which the skins are afterwards thrown. They should be turned over at least three times on the first day, three times on the second, twice on the third, and once on the fourth and succeeding days, until the tanning is finished. The inventor states that a week, or even less, is sufficient for tanning skins on this system, but there is no necessary limit to the duration of the process. The proportions of tan and other substances employed vary with the nature and quality of the skins, but in ordinary cases, about 35 kilogs. of tanning matter to 100 kilogs. of skins will be found to give good results. *Moniteur Indust. Belge, 20th Dec.* 1874.

Manufacture of Chrome Yellow and Orange Lead for Paper-staining.—FAUDEL has made numerous experiments to discover the cause of the changes of colour to which these pigments are so often subject, and the means of obviating them. He finds that sulphur-yellow chrome, manufactured in various ways, and no matter how carefully, always turns a darker shade within twenty-four hours, sometimes within a few minutes, and further, that this change is caused by molecular conversion, not by oxidization, and partly, also, by reduction of the chromic acid. In large establishments, in Holland more especially, the employment of an excess of water in the manufacture often prevents this change of colour. But the most reliable method is that of Gentele, which is as follows: Dissolve 10 parts by weight of neutral acetate of lead in hot water, and when dissolved, add 10 more parts of cold water; also dissolve 2 parts of potassium dichromate in 10 parts of water, and add 1 to 2 parts of English sulphuric acid of 66° Baumé, and dilute with 10 parts of cold water. When the solutions are cold—which is a most essential point—pour the second into the first, agitating briskly. The result is a precipitate of a splendid bright yellow, which is not affected by moderate heat whilst cold, but remedies any slight change that may have taken place in it. The acid, which remains free during the process, has no injurious effect on the paper, and besides, the liquor floating on the top of the colour may be run off with a syphon, and fresh water substituted. An addition of chloride of lime, as proposed by Dahlheim, is not to be recommended—it is wholly unnecessary; the reduction of chromic acid, which it is intended to prevent, does not take place, and it may have the effect of spoiling the colour.

Another yellow, as durable and easy to work as the above, is a yellow with a pronounced orange cast. This is prepared from an empirical receipt, and is so uncertain that the pieces generally exhibit notable differences of shade. Recent analysis has shown that the use of alum and the variability of the temperature at which it is manufactured, are the causes of this uncertainty. A chrome yellow with a very marked orange cast, and perfectly durable, may be prepared without alum, acid, or heat, by dissolving 10 parts of neutral acetate of lead in 10 parts of water, and in another vessel 3·8 parts potassium dichromate in 10 parts of warm water, adding to the latter very carefully 3·6 parts crystallized soda. When the soda is dissolved, pour the second solution into the first, and boil the mixture for half an hour. The two colours first described are distinguished by great durability, and when mixed they produce various elegant intermediate shades. If a more decided orange be desired a difficulty presents itself, as the alum in the sizing of the paper acts detrimentally on orange chromes. These, we know, consist of variable admixtures of neutral and basic chromates of lead; the acid of the alum combines readily with the excess of lead, transposing it wholly or partly into sulphate and neutral chromate of lead, a mixture which is much lighter than that of the basic and neutral chromate. To remedy this, without interfering with the size, we may use salt of tin, as proposed by Erfurt, in place of the alum. Salt of tin, or chloride of tin, has no effect on the colour, and though it is dearer than alum, a smaller quantity—about two-thirds of the weight of the latter—will suffice.

Less commendable appears to be the preparation of chrome orange and chrome red with neutral acetate of lime and litharge, as proposed by Erfurt. The litharge dissolves slowly in acetate of lead, and we are never sure when the solution is complete. But if the basic solution is treated with soda, and precipitated with neutral chromate of potassium, we obtain speedily and surely a pigment full of brilliancy, and covering well. A fine orange may also be prepared by dissolving 10 parts of neutral acetate of lead in 5 parts of boiling water, and 13·6 parts of soda at 12° Baumé, or about 6 per cent. of soda; then dissolve 2·3 parts of potassium dichromate in 2 parts hot water; add 8 parts of the other solution and boil well. *Centralblatt für Papier-Fabrication*, 1874.

§ 4. *Food and Sanitary Matters.*

Grapes in Paris.—Every year above 5,000,000 kilogs. of grapes enter Paris, bringing to the municipality a revenue of 300,000 francs, arising from the *octroi* duty at 5·75 francs per kilog. Between August, 1873, and August, 1874, the commission houses received 3,500,000 kilogs., and 1,500,000 kilogs. were sold by auction, making a total of 5,000,000 kilogs. The consumption increases every year, despite the high prices at which the fruit is sold. There is a great difference between the present prices and those of 1873, the former ruling 10 or 15 cents below those of 1873, which is attributable to the superiority of the crop of 1874, in regard both of quality and quantity. *Les Mondes, 25th Nov.* 1874.

Indian Tea.—A report of the Bengal Chamber of Commerce gives the subjoined as the values of the Indian-grown teas exported annually from Calcutta, during the eleven years ending 30th April last:—

	£
1863-64	229,282
1864-65	273,475
1865-66	226,506
1866-67	362,703
1867-68	683,067
1868-69	860,441
1869-70	1,016,978
1870-71	1,083,502
1871-72	1,358,858
1872-73	1,523,527
1873-74	1,692,699

Consumption of Horse-flesh in France.—During the third quarter of the year 1874, the horse-butchers of Paris sent into the market for human food 284,110 kilogs. of horse-beef, the produce of 1,555 horses, mules, and asses. The number of these animals thus slaughtered during the corresponding periods of previous years was 1,144 in 1872; 626 in 1869; and 535 in 1867. A similar increase was observable in the provinces. The animals fetched on an average 125 to 150 francs each. The principal reasons for sale were confirmed lameness, vice, old age, &c. *Les Mondes, 17th Dec.* 1874.

Thawing Snow with Superheated Steam.—J. MULLALY and JOHN P. HAWKINS (superintendent of the Machine Department at the American Institute Fair) lately addressed the New York Street Committee on the subject of employing superheated steam to clear the streets of snow. The proposal appears to have been rejected, as no funds were available for the purpose. Mr. Mullaly's invention was tried successfully last winter. It consists of a steam generator, which rapidly produces superheated steam, and conducts it to a number of pipes attached to a moveable platform, which can be raised or lowered at will, so as to bring the mouths of the pipes level with the surface of the snow. The machine travels at the rate of three miles an hour, clearing a street section 6 ft. wide. The estimated cost of the machine is as follows:—Boiler, $1,000; tank, $225; carriage, $500; engine and blower, $500; steam-gauge, injector, &c., $150; distributing apparatus, $100; horses and harness, $700; extra horses, $1,200; contingencies, $625. Total, $5,000. The estimated cost of working the machine for 105 days, from the 1st of December to the 18th of March, is $5,974·50.

Additional estimates show the cost of clearing the streets of snow with carts, in the ordinary way, to be $11,647 per running mile; with superheated steam, on the above plan, it could be done for $1,723 per running mile. *American Gas-light Journal, 16th Dec.* 1874.

Behaviour of Birds during Cholera Epidemics.—At St. Petersburg and Riga in 1848, in West Prussia in 1849, and in Hanover in 1850, it was remarked that the jackdaws, sparrows, and swallows abandoned the infected towns, to return only when the mortality had abated greatly or ceased altogether. In Galicia on the 26th of September, 1872, the sparrows left the town of Przemysl some days previous to the irruption of cholera, and did not return until the mortality had ceased. The same thing was observed at Nuremberg and at Munich, where the re-appearance of the birds was hailed with joy by the whole population. It would seem as though the choleraic agency diffused through the air had impelled the birds to escape from its influence. But it should be observed that similar flights have taken place without the appearance of cholera, and exaggerated fears have more than once been awakened by an exodus of sparrows. In Germany the cholera appeared at harvest-time, when town-frequenting birds are wont to quit their usual haunts and take up their abode in the fields for awhile. This may be seen with starlings. About July, after the hay is cut, they quit the towns and betake themselves to the fields in troops, to feed on grass-hoppers, beetles, &c., roosting at nights by the banks of water-courses. In autumn they return to the towns previous to their final migration about a fortnight later. *Les Mondes, 3rd Dec.* 1874.

[During the terrible visitation of cholera in the island of Mauritius in 1854, the mysterious disappearance of the mina-birds, of a species of starling, there called a "martins," during the continuance of the epidemic, was the subject of remark. When the mortality abated, the birds were again to be seen about their accustomed haunts. The electroscope showed a marked change in the state of the atmosphere about the same time.—H. M. C.]

Propagation of Disease by Insects.—MÉGNIN observes that certain blood-sucking flies with lancet-shaped probosci, as the *stomoxes*, *simules*, and *glossines*, which haunt living animals, and avoid those seriously diseased, as well as dead bodies, may nevertheless sometimes be found on diseased animals, and thus become agents for transmitting diseased matter. At Gravelle, where the artillery from Vincennes was encamped for six weeks last year, several *stomoxes* were detected feeding on an erysipelatous sore on a horse's leg, the result of a severe kick. Voluminous ecthymas were obtained by inoculating healthy horses with the matter contained in the flies' suckers, which the microscope showed to contain the bacteria of putrid fermentation, like the serous effusion from the sore. The same fact was noticed in the case of a small fly, scarcely three millimetres long, and perfectly harmless under ordinary circumstances. It is known as *Simula tachetans*, and bites after the fashion of the common house-fly. It often swarms about cow-sheds, and in 1863 was accused of having originated the terrible outbreak of cattle-plague at Condrieux, near Lyons. Professor Tisserant, who started this theory, appears to have seen but half the truth. The fly serves to spread the disease, but it was by acting as a vehicle for the transmission of the carbuncular virus of which the disease was the consequence. *Comptes rendus, lxxix.* 23.

M. Mégnin is persuaded that the action of the African *tsetse* is of the above character. This appears questionable, to say the least. It may be observed that the probability of *stomoxes* serving as media of infection was suggested as long ago as 1867 by Dr. Boisduval in his excellent "Essai sur l'Entomologie horticole."

Preserved Provisions.—In a paper lately read before the Military Medical Society of Vienna, Dr. LEWANDOWSKI observes that the custom of preserving was known amongst the Greeks and Romans. In modern times, Appert succeeded wonderfully in preserving various articles with colour and taste unchanged. The greatest improvements have been made in England, where, especially as regards the navy and the colonies, preserving is carried on in large proportions. Other countries had followed suit. The oldest method is the use of extreme cold; then dessication may be mentioned, obtained in hot countries by simple exposure to the air, and in others by artificial heat. In some parts of America strips of meat several feet long, are powdered with Indian corn meal and salt, and then dried. This meat cooks hard, and has an unpleasant red colour. The French dry vegetables by a current of hot air, and press them into small bulk by hydraulic power. Egg-powder is also prepared in this mode. Then, there is in Saxony and Austria what is called *meat-meal*, which is made by cutting the best pieces of beef into small squares mixed with herbs and vegetables. The mass is then dried and combined with the meal of wheat or peas. This meat-meal when cooked looks like a thick soup, and is tasteless as well as the pease-meal. What is called meat-flour is prepared by drying the beef and grinding it. A miserable product is foisted upon the public by the same name, and is made from the *remains* of the manufacture of the extract of beef. Of course there is no nourishment in it at all. Liebig's extract is well known. According to Pettenkoffer, it contains about 10 per cent. of water, 22 to 24 per cent. of salts, and 56 per cent. of extractions. Albumen, lime, and fat should not be found in the extracts. When mixed with nitrogenous substances or hydro-carbons, it does excellent service. Condensed milk, first introduced by Professor Horsford of Cambridge, is made in Switzerland by adding brown sugar to milk, and boiling the latter in large vessels until it has lost about 75 per cent. of water. It is then placed in air-tight tins. The condensed milk tastes sweet; the caseine is in perfect solution, and the proportion of butter is quite nominal.[1] Dr. Lewandowski mentions also the method of preserving with the aid of substances that abstract moisture, as sugar, common salt, and saltpetre; the smoking of meat; and a new mode of preserving by exposure to antiseptic gases, such as sulphur-gas, carbon oxide, &c. Fruit may be preserved by covering it with a substance to exclude the air. Even made dishes may be preserved by being placed in tins and mixed with a hot sauce or filtered boiling-water. The lid, in which is a small hole, is then soldered down, and the tin subjected to a high temperature. The liquid escapes as a fine steam-jet through the hole, which latter is then quickly soldered over. *Lancet, 9th Jan.* 1875, from *Allgemeine Wiener Med. Zeitung, Dec.* 1874.

LECHARTIER and BELLAMY have found by experiment that fruit contained in closed vessels sometimes undergoes changes resembling those produced by alcoholic fermentation, although

[1] See "Practical Magazine," Oct. 1874, p. 253.

no traces of ferment may be present. M. Pasteur explains this fact by the assumption that the molecules of the fruit undergo a certain organic change, by which they become assimilated to the molecules of ferment. In potatoes and beetroot thus decayed, *bacteria* were observed. This was not noticed in fruit and in other descriptions of vegetables experimented upon. *Comptes rendus*, 1872-4.

Test for Alcohol in Liquids.—PAUL and BOURGUIGNON, of Montpellier, propose the following method: Pour a few spoonfuls of the liquid into a saucer, adding several drops of concentrated sulphuric acid. When well mixed, add a spoonful or two of tincture of Brazil wood (Pernambuco wood, or *Cæsalpina ebenata brasiliensis*). If no alcohol is present, a granular reddish-brown precipitate immediately forms; if alcohol is there, the precipitate does not appear for some time, longer in proportion as the liquid is richer in alcohol. If the liquid contains tinctorial essences, it must first be passed through an alembic.

To distinguish vinous alcohol from commercial alcohol, mix a few spoonfuls of the liquid with a spoonful of nitrate of magnesia, well pulverized, and very carefully dried. Heat over a spirit-lamp until the solution is complete, stopping before sublimation. Let fall a few drops on a sheet of paper or a strip of glass. Vinous alcohol forms solid pastilles, which crumble away under the nail. Commercial alcohol forms soft, honey-like pastilles, which stick to the paper instead of breaking away like the others. *Bulletin de la Soc. Chim. xxiii.* 1. 1875.

§ 5. *Fuel, Heating, Illumination, &c.*

Petroleum for Burning Brick.—In Canada a burner is in use in which crude petroleum is employed in place of coal or wood for burning bricks. By a simple contrivance the nozzle of the burner is made to throw the flame directly downward at the first firing, and after burning the head (as it is termed), the nozzle is replaced by a straight one, the change being effected in a few moments. The flame is, therefore, thrown into the arch any required distance, burning the whole kiln from one end, and doing it in much less time than by the old method, and with perfect success as regards the quality of the burning. One man by this process will be able to do as much firing as a dozen with the old, as he can attend to as many arches as may be set going in one yard, and by this means save a large item in labour. The tar or petroleum consumed will not cost as much as wood at 14*s.* per cord.

Mineral Oils in New Zealand.—W. SKEY (analyst to the Geological Survey of New Zealand) states that mineral oils have long been known to exist in the colony in the shape of films on the surface of the water of springs and wells of little depth. There is reason to believe that they could be found in fair quantity if properly worked. Up to January, 1874, three samples had been analyzed.

No. 1. From the Sugar Loaves, Taranaki.—A very remarkable oil, its sp. gr. being ·960 to ·964 at 60° Fah., water as 1. The heaviest petroleum mentioned by Gesner has a specific gravity of ·930 only. It differs from most petroleums in not containing paraffin, in which respect it resembles a so-called surface-oil occurring in Santa Barbara Co., California.

It appears of a dark green colour by reflected light, and, unlike most rock oils, has a mawkish but by no means unpleasant odour.

By a course of fractional, and apparently destructive distillation, it breaks up into a series of oils considerably lighter than any present in the natural oil, and into heavy oils, naphthaline, and tarry matters. With suitable apparatus it might be rendered fit for illuminating purposes; but whether this could be done at a reasonable cost is questionable. It appears most fitted for use as a lubricant. It is not solid at 5° Fah.; its volatilizing point is 340° Fah.; and it remains entirely unchanged when exposed to the air at ordinary temperatures.

No. 2. From Poverty Bay, east coast of province of Auckland.—A true paraffin oil, resembling Canadian oil. Transparent red by transmitted, and blackish green by reflected light. Odour that of crude petroleum. Sp. gr. ·864 to ·871 at 60° Fah. Almost 65 per cent. may be obtained sufficiently light to burn well in ordinary kerosene lamps.

No. 3. From Manutahi, Waiapa, East Cape.—A very superior oil, the lightest yet tested in the colony. Contains at most but traces of paraffin. Colour pale brown, nearly or quite transparent, does not show blackish green by reflected light. Odour of kerosene. Shows no increased consistency at + 8° Fah., whereas all the kerosenes in the colonial market solidify at this temperature, and the Poverty Bay petroleums at higher temperatures. *Transactions of New Zealand Institute, vol. vi.* 1873-1874.

Delachanel and Mermet's New Lamp.—FRANCK DE VILLECHOLLE, the well-known Parisian photographer, reports of this lamp (described in the "Practical Magazine," Dec. 1874, p. 466) as follows:—When placed in a dark-chamber at 2m. distance from an engraving, a negative was obtained in five seconds—the operator's own likeness was obtained in like manner in fourteen seconds. The gaseous products of combustion were carried out of the chamber by a chimney provided for the purpose. He considers the photogenic power of the lamp to be superior to that of the magnesium light, twice as great as that of the oxy-hydrogen, and three times that of the electric light. It gives a steady flame without intermissions, and without the risk, as in the magnesium light, of spontaneous extinction. The magnitude of the flame, 25 centimetres long, permits very wide surfaces to be illumined. It is also cheaper than the other lights. The flame gives a banded spectrum crossed by numerous fine bright lines. Experiments have been instituted by the inventors to ascertain whether, like the magnesium and electric lights, it affects the development of the green colouring matter of plants.

Unpretentious as the invention seems, it promises to revolutionize the photographic art by rendering operators independent, in a great measure, of solar aid. *Revue Indust. 25th Nov.* 1874, *Moniteur Indust. Belge*, 10*th Jan.* 1875.

New Petroleum in Algeria.—The discovery of a new petroleum in the country of the Beni-Zarouel, in the province of Oran (Algeria) is recorded in the under-named journal. It is a soft glutinous petroleum, melting in boiling water, and soluble in turpentine. It burns with a white flame, giving out much heat, and evolving empyreumatic fumes. The residue is purely carboniferous, without any trace of bituminous matter, and is indestructible. It is neither an asphalt, a naphtha, nor a bitumen, but possesses properties common to all three substances, resembling naphtha more than either of the others; although, unlike naphtha, it is not soluble in alcohol. It is well suited for a great variety of industrial purposes. *Revue Indust. 6th Jan.* 1875.

Gas Hydrometer.—M. MAUMÉNÉ has submitted to the Academy of Sciences a new instrument thus named, by which the gas evolved in various descriptions of industrial analysis, as of limestone, coal, &c., can be measured by the displacement of an equal volume of water. The instrument consists of an india-rubber bottle, the neck of which fits into a short copper pipe carrying an india-rubber tube, the opposite extremity of which terminates in a small syphon passing through an india-rubber stopper, which hermetically closes the test-vessel. The india-rubber bag is enclosed in a copper cylinder filled with water and fitted with an india-rubber stopper with two holes, through one of which passes the india-rubber tube; the other is for the escape of the water as the bag becomes inflated with gas. Let it be required to ascertain the proportion of carbonic acid in a particular sample of limestone. A certain weight of the sample, carefully pounded, is placed in the test-vessel, which is filled up with hydrochloric acid and carefully stoppered. As the gas is evolved it passes through the tube into the india-rubber bag, which being inflated displaces a proportionate volume of water. The water so displaced is ejected through the hole provided for the purpose, and caught in a graduated éprouvette. The corresponding reading on the scale of the éprouvette indicates the volume of gas disengaged. *Comptes rendus, lxxix.* 25.

§ 6. *Engineering.*

Elasticity of Railways.—COGGIA, after considering the various types of permanent way in present use, arrives at the following conclusions:—

No existing system of permanent way gives, in practice, perfect uniformity of action.

Stability in a line of permanent way cannot be secured by immobility, except at the cost of durability.

Lines of permanent way will not prove economical unless they are formed of durable materials, and work with a suitable degree of elasticity.

This elasticity does not exist at the points of junction of the rails, and cannot be maintained except under the unattainable condition of maintaining permanent unalterability of the whole superstructure.

Lastly, it is thought the problem can be solved only by the adoption of a line of way formed of metal alone, which shall be at once flexible and resistant, the flexibility being as great at the points of junction as in the middle of the lengths of rail, and the stability as absolute as may be compatible with mobility, and the elasticity of which will ensure its durability.

He endeavours to prove that oscillations of the points of support in a ballasted line are a necessary feature of all lines of railway laid on sleepers. The result of this want of fixity in the points of support is, that the rails, when subject to the pressure of a passing train, do not, as they should, perform a series of oscillations, the highest points of the curves described being on the upper surfaces of the sleepers; but instead, they undergo an inflection at each successive point of their length immediately in front of the incumbent weight. The amplitude of the depression so produced would be constant if the subjacent soil offered a uniform degree of resistance, if the ballast were perfectly homogeneous, and the superstructure could be established and kept in a suitable state, as regards uniformity of action, solidity, and rigidity.

Whatever may be the effect of this flexion on the durability of the rails themselves it is essential to the working of the line, as it affords the best guarantee against shocks, and carriages running off the rails, and it is indispensable to render it as uniform in its action as possible, as in this way alone are we enabled to increase the speed and to avoid the risk of broken axles. *Paper read before Soc. des Ingénieurs Civils, Paris,* 1874.

Many experiments have been tried in France to test the effects of cold on railway-axles. Many engineers suppose that accidents oftentimes do not result from any diminution of tenacity in the metal, but merely from the road losing its elasticity owing to the frost hardening the surface of the ground. A fact which can be adduced in strong confirmation of that theory was observed by the inhabitants of Montmartre during the late frosts. The passing of the trains, which so frequently run through the Batignolles tunnel, at a distance of half a mile, was heard night and day, whilst it never is heard under ordinary circumstances. As soon as the thaw set in, the earth recovered its elasticity, and the sound ceased to be heard. It has been observed by French railway engineers that thaws are apt to lead to the breaking of axles and chains. The elasticity being only partially restored, many shocks affect the trains when running at a fast rate, and are apt to lead to catastrophes. *Nature, 8th Jan.* 1875.

Decay of Railway Sleepers prepared with Copper Sulphate.—MAXIME PAULET observes, that the chemical reactions which take place in wooden sleepers thus prepared and laid in ballast are not always as simple in their character as usually is supposed. Take, for instance, the case of a beechwood sleeper prepared with copper sulphate, which has lain in ballast on a line of railway for eight or ten years, and has been taken up because found to be partially decayed. The affected portions of the wood are very dark near the points of contact with the rails; it is not mouldy, but its chemical composition has become changed. It no longer contains any appreciable quantity of copper; but instead is found a considerable, sometimes an enormous, proportion of iron supplied by the rails or chairs, although the presence of the iron has not prevented the decay of the wood. The iron has entered the wood in a soluble state, as it has penetrated to some distance into the substance. This result upsets all recognized theories. In examining the wood we must first set aside the portions which have been in immediate contact with the ironwork, or in communication with it by cracks and flaws produced by the drying of the wood and forming channels for the moisture, as the presence of rust in such portions would interfere with the investigation. This done, we shall find that the fibres of the other portions of the wood in proximity to ironwork are very dark, offer no resistance, and crumble away very readily. The density is curiously reduced; fragments of sleepers in this state showed a density of 0·380 gr., whilst a similar fragment of one of the same sleepers, which had not become changed, showed a density of 0·755 gr. The chemical characteristics of the decayed portion were found to be as follows:—Caustic potash and even ulmic acid dissolved it completely. Treated with water containing nitric acid, it separated lime and a considerable quantity of iron. The iron, which must have penetrated the wood in a state of solution, was insoluble; and ferro-cyanides of potassium applied to a piece of the same wood gave no blue stain. Whilst the nitric acid was separating the iron, a continual evolution of carbonic acid was observed, as if the acid were acting on impure carbonates. This volume of carbonic acid far exceeded that produced by wood decayed in the ordinary way.

Fresh beechwood contains no carbonates, and no carbonic acid. A piece of the decayed wood measuring ·66 centm. cube, and weighing 6·250 gr. gave 10·5 cubic inches of carbonic acid, or more than 12 cubic metres of carbonic acid to the cubic metre of wood. The mineralized wood gave a large proportion of ash; after exposing the ash to a red-heat for some time, the weight was found to amount to 3 per cent. of that of the wood; in fresh beechwood the proportion is less by half. When boiled in acidulated water, a portion of the wood becomes dissolved; and when the solution is concentrated in a platinum capsule, the residuum blackens and chars before calcination. When the wood is deprived of the salts with which it is impregnated, its density is further decreased, falling to 0·302 gr.

This description applies to the decayed portions in the vicinity of the rails and bolts. The other portions of the sleeper do not exhibit this ultra-ferruginous constitution, so long as the ballast is not surcharged with oxide of iron; but in these portions carbonate of lime is always very abundant. The copper gradually separates, giving place to carbonate of lime. How is this effected? The carbonate of lime in the ballast, rendered soluble by an excess of carbonic acid, gradually penetrates the wood and replaces the copper. To determine the amount of change undergone by the wood, we have only to determine the quantities of carbonic acid and carbonates it contains. The copper, so to speak, recedes as the lime advances. So long as the copper remains in its original state its conservatory action continues. The carbonate of lime is not a preservative, and it interposes between the material to be preserved and that designed to preserve it; and the latter is reduced to a condition that facilitates the access and action of destructive agents. This explains why sleepers prepared in this way so soon perish in calcareous soils. Sometimes the metal remains in the wood as in the portions in contact with the rail; but the oxide is simply mechanically interposed, not in a state of combination. There may, perhaps, be a reducing action exerted by the organic matter on the oxide; but generally speaking, when the wood has laid sufficiently long in the ground the copper will be found to have disappeared altogether. Separated from the albumen at first, it is in the end carried off from the ligneous tissues as well by the carbonic acid. Another solvent is also not unseldom present, although in smaller quantities; this is carbonate of ammonia furnished by organic matters in the ballast, out of which it is washed by the rains. *Comptes rendus, lxxx.* 1.

Experiments with Belting.—OGIER communicates to the Société des Ingénieurs a series of experiments with driving-belts. The belts were of two kinds:—1. Leather belts; 2. composite belts, *i.e.* belts of folded canvas and vulcanized caoutchouc. Cast-iron pulleys were used in every case.

Description of belt used.	Breaking weight per square millimetre of section.	Elongation per metre.			
		With a weight of 0·25 kilogs. per sq. millimetre.		With a weight just under breaking weight.	
		Elastic.	Permanent.	Elastic.	Permanent.
	Kilogs.	Metres.	Metres.	Metres.	Metres.
1. Leather, 50 mm. × 6 mm. .	2·246	0·107	0·022	0·233	0·095
2. Leather, 50 mm. × 6 mm. .	2·246	0·094	0·022	0·275	0·095
3. Composite, two folds of canvas, 51 mm. × 3·5 mm. . . .	2·640	0·027	0·002	0·074	0·011
4. Composite, two folds of canvas, 51 mm. × 3·5 mm. . . .	2·808	0·029	0·002	0·071	0·012
5. Composite, two folds of canvas, 51 mm. × 2·8 mm. . . .	3·622	0·058	0·002	0·144	0·008
6. Composite, four folds of canvas, 51 mm. × 7·5 mm. . . .	2·640	0·058	0·002	0·123	0·008
7. Composite, four folds of canvas, 51 mm. × 7·5 mm. . . .	2·443	0·043	0·002	0·084	0·008
8. Composite, six folds of canvas, 51 mm. × 12 mm. . . .	2·246	0·048	0·002	0·088	0·008
9. Composite, six folds of canvas, 51 mm. × 12 mm. . . .	2·243	0·049	0·002	0·110	0·007
10. Composite, four folds of canvas, 97·5 mm. × 7 mm. . . .	2·640	0·033	0·002	0·083	0·012

The results of these experiments may be summed up as follows: The co-efficient of friction of composite belts on cast-iron pulleys varies from 0·42 to 0·84, that of leather belts being 0·28. The *minimum* was obtained, in the former case, with belts formed of canvas with caoutchouc applied *externally* only. With pulleys of different shapes, the maximum of friction was obtained with pulleys of slightly convex shape and somewhat roughly granulated surfaces. With leather belting the reverse was the case. The effect of lubricants on composite belts was found to be the reverse of that on leather. Covering the former with a light varnish formed of equal portions of soot and oil melted together, was found to increase the hold. This is attributed to a sort of resinification produced by the excess of sulphur which finds its way to the surface of the caoutchouc after a certain length of time.

The table given above shows the results of experiments made to determine the breaking strain and the average elongation—elastic as well as permanent—of leather and composite belting. The experiments were made with belts 2·50 metres long, the ends secured with iron clips 0·60 metres long, a length sufficient to prevent slipping, without giving undue rigidity. One of the clips

was made fast to the hook of a crane, to the other was suspended a wooden box, to contain the test-weights. The elongations were measured, in each case, after an application of the strain for one hour and a half. The failure of composite belts is almost always occasioned by workmen accustomed to leather belting tightening them overmuch when they slide, and so breaking them, or causing them to wear out unduly fast. In the present state of the leather and india-rubber trades, the useful effects of leather and composite belts of equal price may be considered as equal; but the repair of composite belting is much less costly than that of leather belting of large size. *Moniteur Indust. Belge*, 10*th Jan.* 1875, *from Paper read before Société des Ingénieurs Civils*, 1874.

Belgian and German Experiments with Railway Bearings.—KUNZEL gives the following as the essentials of a good bearing:—1. It should not cut the arbor. 2. It should wear itself as slowly as possible. 3. It should not heat, even when in want of grease. 4. It should have sufficient tenacity to withstand all shocks which it is likely to experience, without breakage or loss of shape. The alloys of copper and tin in common use are seldom homogeneous, if we except that composed of 82 or 83 parts of copper to 17 or 18 of tin. Those containing a smaller proportion of tin undergo a sort of granulation in cooling, which alters the homogeneity of the metal. This is a grave defect, as it inevitably entails unfair wear both of the bearing and the arbors. When an alloy of copper and tin is slowly cooled, the portion which sets first is a very soft compound, containing 7 to 10 per cent. of tin only; this, as it were, forms the substance of the metal, whilst the harder portions of the alloy, containing 17 to 18 per cent. of tin, solidify more slowly, filling up the voids in the former. When a bearing of this description is used, the softer portions wear fastest, and the harder granulations then project, and cause undue friction, whenever the supply of grease runs short. A good bearing should have a very hard shell, in which the voids should be filled with a softer metal. The table annexed shows the results obtained in various Belgian and German lines of railway with bearings composed of alloys of different composition and degrees of fusibility:

Description of Metal.	Composition of Metal.	Price per kilog.	Loss of weight in four carriages per 1,000 kilos. travelled.	Cost per carriage per 1,000 kilos. travelled.	Railways on which tried.
		Francs.	Grams.	Francs.	
Bronze	Copper . 83 / Brass . 17	3·25	11·6	0·037	Austrian Lines of Railway.
	Copper . 82 / Brass . 18	3·25	—	0·032	Grand Central Belge Ry.
do.	Copper . 82 / Brass . 18	3·25	109·5	0·355	do.
White Metal	Copper . 3 / Brass . 90 / Antimony 7	3·73	14·8	0·055	Austrian Lines.
	Copper . 5 / Brass . 85 / Antimony 10	3·66	11·3	0·041	N. Schlesische-Märkische Railway.
	Lead . 84 / Antimony 16	1·48	12·2	0·018	Austrian Lines.
Phosphorus Bronze.		4·37	2·3	0·010	Grand Central Belge.
do.		4·37	9·5	0·041	do.

Moniteur Indust. Belge, 1*st Jan.* 1875.

§ 7. *Building, Decoration, &c.*

Manufacture of Bricks, Tiles, &c. without Firing.—DELEON, AGLET, and FRANC give the subjoined details of their new process for the instantaneous manufacture of bricks, tiles, artificial stones, imitation marbles, lithographic stones, grindstones, &c. without firing.

1. *Bricks, hollow or solid.*

Powdered lime	1750	parts by weight.
Sand	750	,,
Magnesia	72	,,
Chloride of magnesia	100	,,
Carbonate of soda	25	,,

The ingredients are mixed in the following order:—first, the lime, sand, and magnesia; then the chloride of magnesia; lastly, the soda. They are well mixed after each addition, and the material is then ready for moulding, either by machine or by hand.

The chemical reaction of the ingredients takes place immediately, and the hydraulic aggregation is, so to speak, instantaneous. It is stated that a solid brick of ordinary dimensions thus manufactured is capable of supporting a weight of 27·400 kilog. as soon as made. The proportions of the several ingredients in the composition are varied according to the object in view, as below:—

2. *Drainage pipes, ridge tiles, &c.*

Powdered lime	1356·00	parts by weight.
Sand	580·00	,,
Magnesia	55·75	,,
Chloride of magnesia	77·45	,,
Carbonate of lime	19·36	,,

3. *Artificial Stone.*

Powdered lime only is employed; the sand is suppressed. The weight of the other substances are as in No. 1. Powdered lime may be mixed in nearly equal proportions with calcined clay, with very nearly the same results.

4. *Imitation Marble.*

Powdered marble	5	parts by weight.
Magnesia, chloride of magnesia, and carbonate of soda, mixed together in same proportions as in No. 1.	1	,,

Objects of art of every description, statuettes, vases, chimney-pieces, columns, stands, ornamental tiles, mosaic-work, &c., may be thus manufactured, and coloured with ochres or mineral colours.

5. *Lithographic Stones.*

Mix Jura or other similar limestone, with fragments of lithographic stone, or a mixture of lithographic stone and limestone, in the following proportions:—

Mixture of chemical substances mentioned above	40	parts by weight.
Lime in fragments	60	,,

Moniteur Indust. Belge, 10*th Jan.* 1875.

Portland Cement Concrete.—Major MAQUAY, R.E., observes that Portland cement concrete is susceptible of very general application to almost every description of work forming part of permanent fortifications, and that great economy accompanies its use, where suitable materials are procurable near the site of the works. For coast-defences, therefore, this concrete can be applied with the best advantage, as the shingle, sand, and salt water, which form its principal ingredients, are generally on the spot.

Military works constructed of this material, both of a massive and a slight nature, have been carefully watched for the special purpose of ascertaining whether this concrete expands or contracts to any degree in setting or from changes of temperature, but no traces of such expansion or contraction could be observed. The concrete does not attain its ultimate maximum hardness and strength for probably two years, but after a few months it becomes sufficiently set to admit of the utilization of the buildings constructed with it. This property is of great value in military works, as it enables revetments and bomb-proof covers to be loaded with earth almost as soon as completed. The resistance of Portland cement concrete to projectiles has not been determined, but when used for backing shields and targets, the penetration of elongated shells from rifled ordnance has been found to be about one-third greater than in granite masonry similarly situated, although, as there were no joints, the disruption of the mass was less than in masonry. The slopes of gun-emplacements made of this concrete are not affected by the shock of the discharge of guns fired over them. On these surfaces all plastering and rendering should be avoided, and the finishing layer of concrete should not be less than 9 in. thick. As the concrete dries of a light colour, it should be discoloured when used in batteries, especially under the muzzles of the guns, so as to bring all parts to the colour of grass or earth. Stockholm tar and yellow ochre mixed with paraffin or turpentine make a very good wash, that can be toned down to imitate earth-work, and Woodfall and Co.'s patent liquid paints are also durable on concrete surfaces.

Portland cement concretes may also be used in almost all branches of the building trade where stone is now used. For tanks of all sizes and drains it is well suited; channel courses moulded in concrete will stand wheel-traffic, and traps for drains can be moulded in this material with the frames for the gratings cast in them; it is also applicable for hearthstones, sinks, mouldings, cornices, &c.

The cement should be heavy and ground very fine; 110 lbs.

to the bushel is good weight. Cement lighter than this will set fast, but not attain so great hardness as a heavier cement. The greater the fineness the more its cementing properties will be developed; all coarse particles of cement are only so much sand in the powder; for this reason, any excess over 20 per cent. which will not pass through a sieve of 2,000 meshes to the square inch should be rejected or deducted from the quantity received from the contractor. Should the cement contain too much chalk in its constitution, the defect may be detected during the testing by the wet "pat" cracking and swelling; or if it contains more than a proper proportion of clay, it will show itself by the pat shrinking and setting of a yellow instead of a light-grey colour. In either case it is desirable to reject the cement, though its tensile strength may come up to the required test.

In testing cement it is more satisfactory to come to a conclusion as to its quality after the briquettes formed of it for test-purposes have had a month, or even three to set under water; as a delay of this kind would generally be inadmissible, seven days' immersion in water is the time generally allowed. As regards the other ingredients, the broken stone, shingle, and sand should be perfectly free from clay, earth, and dust, and no more water should be added than is necessary to moisten the ingredients. If any blocks of stone or bricks are built into the concrete, they must be saturated with water and their surfaces perfectly clean. As a rule they should be set on their ends. The ramming should be evenly and gently distributed over the whole work. In joining fresh concrete the surface of the old should be rough, clean, and well moistened. *Proff. Papers, Corps of Royal Engineers*, 1874.

Timber in Italy.—The annexed table shows the extent and distribution of timber land in Italy :—

Districts.	Population.	Area.		Proportion of Wood Land.	
		Unwooded Land.	Wooded Land.	To the Population.	To the Superficial Area.
		Hectares.	Hectares.	per cent.	per cent.
Piedmont and Liguria.	3,535,736	3,432,798	638,316	18·05	18·59
Lombardy	5,601,280	4,718,982	846,749	15·11	17·94
Modena	490,645	539,025	57,186	11·65	16·09
Parma	474,598	573,945	153,053	32·24	26·66
Tuscany	1,997,067	2,403,109	634,355	32·24	26·38
Late States of the Church (Rome, Civita Vecchia, Viterbo, &c.)	2,435,683	2,934,475	427,272	17·12	14·55
Naples	6,787,289	8,530,959	1,097,927	16·18	12·87
Sicily	2,392,414	2,924,024	125,513	5·24	4·29
Sardinia	588,064	2,425,018	1,045,022	77·79	13·12
Total	24,273,776	28,482,335	5,025,893	—	—

L'Economista, 26th Nov., 1874.

Encaustic for Arms, Metallic and Varnished Surfaces, &c.—CHEVALLIER (Les Sieurs) patents the following :—

Bones, calcined and scraped	100 kilogs.
Stearine, scraped	100 grammes.

Grind; add 50 grammes quicklime; mix into paste with water and pound well. Apply with a linen rag. Lime must be omitted when the preparation is to be used on stuffs for facing, &c. *Bulletin de la Soc. Chim. de Paris, xxii.* 11.

Waterproof Compositions.—The following may be applied to wood, stone, and metallic surfaces to render them waterproof :—

Coal tar	55
Emery powder	35
Acetate of lead	5
Alum	3
Sulphate of ammonia	2

Another: Dissolve casein in ammonia water; add varnish, oil, and glycerine, and boil. After cooling, add some bichromate of potassium. Apply the composition with a brush; dry, and expose to the light. *Moniteur Indust. Belge, 20th Dec.* 1874.

Construction of Chimneys.—A short time since the Prefect of the Seine issued an order respecting the construction of chimneys in private buildings. The Chamber of Masons, considering the regulations prescribed would create at times innumerable difficulties, appointed a commission to report on the subject, which report has been unanimously adopted by the Chamber. The following are the regulations proposed by the masons :—

1. No chimney shaft shall be formed in stone walls of less than 40 centm. (16 in.) thick, plaster included, or in brick walls of less than 37 centm.

2. Chimney-shafts in the interior of walls shall only be constructed of bricks or of terra-cotta, which shall key into the materials of the walls itself. The use of the *boisseaux* or *pots* of burnt clay (short quadrangular tubes with a lip, now in common use,) is absolutely prohibited.

3. The tongues of the pipes engaged in the brick work of the chimney shall never be less than 8 centimetres in length.

4. Between the interior surface of the chimney-shafts and that of any bays formed in the wall, there shall always be 25 centimetres of solid masonry, plastering included.

5. Chimneys built against piers in masonry, walls in ashlar work, being at least 40 centimetres in thickness, brick walls of at least 22 centimetres in thickness, or in garrets against brick partitions of 11 centimetres in thickness, may alone be constructed by means of tongue-pieces in plaster, or with burned-clay *boisseaux* covered with plaster.

6. The tongue-pieces, in the *boisseaux* covered with plaster above referred to, shall never be less than 65 millimetres ($2\frac{3}{5}$ in.) in thickness over all.

7. Isolated chimney-shafts, or groups of such shafts, must be constructed in the same manner and of the same materials as shafts constructed within walls.

8. Every chimney-shaft ought to have a section equal to three square decimetres or about $\frac{1}{3}$ square metre. The smallest side of such rectangular shafts not to measure less internally than 15 centimetres (6 in.), and the angles to be rounded off with a radius of 2 in.

9. In every new building the necessary arrangements must be made in the roof to afford easy access to the top of the walls against which chimney-shafts are constructed, and when the chimneys are within the walls, they shall be made near the chimney-shafts themselves, so that the mouths of the chimneys shall be accessible without difficulty. *British Architect, 15th Jan.* 1875.

§ 8. *Miscellaneous.*

Drying Glue.—To obviate the ill consequences of extremes of temperature and changes of weather in the manufacture of glue, FLECK proposes desiccation in the presence of certain salts. When a solution of gelatine is treated with sulphate of ammonia, sulphate of magnesia, or hyposulphuret of soda or Glauber's salts, the gelatine contracts into an elastic mass no longer susceptible of fermentation, and containing but 18 per cent. of water. Mixed with fresh glue, which contains 80 or 90 per cent. of water, it makes a glue of medium consistency, easily soluble, containing 53·4 per cent. of water, and resembling that prepared for cloth-workers' use by Stalling of Dresden. Undried glue contains 72 to 93 per cent. of water; glue carefully dried in the air, 12 to 15 per cent. only. The problem is therefore to eliminate 60 to 80 per cent. of the water as speedily as possible without injury to the quality of the glue. If the bottom of a flat vessel be covered with a layer of the above-mentioned salts, and the sheet of glue laid thereon between two damp cloths, the salts quickly deliquesce. At the end of twelve or eighteen hours this ceases, and the sheets will be found to contain 25 per cent. of water only. Desiccation can thus be effected without the risks of melting and putrefaction in summer or congelation in winter. The glue gains rather than loses in respect of adhesive powers. It, however, retains 3 to 6 per cent. of the salts employed, which although they do not impair its quality, give it a dull appearance, like Russian glue. The salts can be dried by evaporation and used over again. *Moniteur Indust. Belge, Dec.* 1874.

Cleansing Wool.—RAULIN proposes the following method :—A current of air at 30° to 40° C. is passed through the raw wool, followed by a current of hydrochloric acid gas, previously dried and cooled. In this way the wool is not affected, but any vegetable substances adhering to it are speedily decomposed. A current of cold air is then passed through to dispel the hydrochloric acid gas, and the temperature is gradually raised to 130° C. to complete the destruction of the vegetable matters. Lastly, a current of air charged with ammoniacal vapour is passed through to get rid of any remaining traces of hydrochloric acid. *Les Mondes, 3rd Dec.* 1874.

Gunpowder.—ROUX (Director of Dépôt Central des Poudres et Salpètre) reports that experiments with the calorimeter prove that gunpowder containing 82 parts saltpetre, 4 of sulphur, and 14 of charcoal, develops the maximum of heat.

Trials of this powder against French Government powder (76 saltpetre, 10 sulphur, 14 charcoal), and English powder (74 saltpetre, 10·5 sulphur, 15·5 charcoal), all three samples manufactured at Esquerdes, showed that powder developing the maximum of heat gave velocities sensibly inferior to those of the other two powders. *Revue d'Artillerie, Dec.* 1874.

"Monaco Mastic" for Coopers.—SCHAEFFER patents the following compound for coopers' use :—

Tincture of magnesia . . .	5 parts
Boiled linseed oil	15 „
Monaco olive oil	3 „
Sulphate of lead	38 „
White lead	23 „
Pulverized Monaco sand . .	4 „
Carbonate of iron	12 „
	100 parts.

Grind for 10 hours; throw the mastic into a cistern, and allow it to stand for three weeks; then re-grind for four hours, passing it through four granite rollers. *Bulletin de la Soc. Chim. Paris, xxiii.* 1.

Common Error in Computing the Value of Substances containing Water.—IVAN STEINBACH calls attention to an error very commonly made in computing the value of commercial products containing water or other matters of no value. Take, for example, soap, and let it be assumed that 100 kilog. of soap, containing 30 per cent. of water, are valued at 64 fr. It is found on delivery that the soap contains 33 per cent. of water.

What is the corrected price?

The computation should be made thus. In the 100 kilog. containing 30 per cent. of water, 64 fr. represents the value of 70 kilog. of dry soap. But as the 100 kilog. delivered contains 33 per cent. of water, but 67 kilog. of dry soap are contained therein. Thus,

$$\frac{67}{70} \times 64 = 61{\cdot}25 \text{ frs., the corrected price.}$$

The difference between 64 and 61·25 frs. = 2·75 fr. is equivalent to the price of 3 kilog. of dry soap.

Generally speaking, the practice is to deduct the price of 3 kilog. of soap, as delivered, which in the above case would be 0·64 × 3 = 1·92 fr. An error against the buyer of 2·75 fr.—1·92 fr. = 0·83 fr. per 100 kilog. is thus made.

The absurdity of this practice is rendered more apparent thus :—

We have seen that 3 per cent. is the correction made for 33 per cent. of water; therefore,

For 40 per cent.	the correction would be	10	per cent.
„ 60	„	30	„
„ 90	„	60	„
„ 99	„	69	„

Consequently, according to this rule, if the material contained 100 per cent. of water, *i.e.* no soap at all, only 70 per cent. of the price would be abated. *Bulletin de la Soc. Indust. de Mulhouse,* 1874.

Turf Paper.—BEITMAYER lately exhibited before the Polytechnic Society of Berlin, samples of paper and cardboard manufactured from turf dug in the neighbourhood of Königsberg. The quality was excellent. The cardboard was 8 millm. in thickness, and stout enough to take a good surface; the paper was thin and brittle, like that manufactured from straw and wood; but it was stated a very good paper could be produced by mixing 15 per cent. of rags with the turf. The turf is prepared by compression in presses of a particular make, which gives the required density, and gets rid of a considerable proportion of the water it contains. *Bulletin du Musée de l'Industrie de Belgique,* 1874, *from Industrie-Blätter.*

Materials for Paper-making in New Zealand.—T. KIRK calls attention to the undermentioned plants, which are indigenous to New Zealand, and suited for paper-making. All are abundant, and all are destroyed to an enormous extent every year by the progress of settlement. Several of them might be cultivated, so as to obtain a regular supply.

Kahakaha: *Astelia Solandri.* The "tree flax" of the settlers. Abundant on lofty trees and rocks throughout the colony, usually at elevations of 2,500 to 3,000 ft. above sea-level. Hundreds of tons are destroyed with every acre of forest land cleared.

Kowharawhara: *Astelia Banksii* and *A. Cunninghamii.* Same habit as last, but with narrower leaves, yielding a superior fibre. *A. Cunninghamii* is common on trees and rocks. *A. Banksii* occurs in immense profusion in woody places near the sea. Both are found in the northern island; their southern distribution is uncertain.

Kawri-grass: *Astelia trineria.* Most abundant of all. Forms the chief part of the undergrowth of the northern forests up to altitudes of 3,000 ft., and is so dense that it is often difficult to force one's way through it. Could be procured by hundreds of tons. Experience shows that it may be cut annually.

Ti, or Cabbage-tree: *Cordyline australis.* A small tree 6 ft. to 25 ft. in height. Extremely abundant; produces large quantities of fibrous material; might easily be cultivated. Some years ago leaves of the plant were sent home to England and manufactured into paper at one of the Yorkshire mills. It was highly commended in an English trade journal at the time, and the propriety of importing a constant supply was advocated.

Ti Ngaherehere: *C. Banksii.* A smaller plant with superior fibre, but in less quantity. Abundant in forests, gullies, &c. Could easily be cultivated.

Cutting grasses, such as *Gahnia setifolia* and *G. ebenecarpa,* are suited for coarse paper. Other sedges and grasses might also be used, especially the curious "sand grass," *Spinifex hirsutus,* and the "sand fescue grass," *Festuca littoralis.* The latter might serve as a substitute for Esparto. The curious sedge called "pingo," growing on shifting sands, and the tawera or New Zealand screw-pine, *Freyconetea Banksii,* which is abundant in tall woods, and climbs to the tops of the loftiest trees, might be procured by thousands of tons. Nikan might be turned to account for coarse paper. The merits of *Phormium tenax* have been recognized, and a company has been formed at Auckland to manufacture it into paper. Species of *Celmisia* known to settlers as "cotton grass" and "leather grass" might also be used. Wheaten straw, which at present is of little value in the colony, might also be turned to account. *Transactions of New Zealand Inst. vol. vi.* 1873-4.

Mustard in Rape-Cake.—The under-named journal records a serious loss of valuable live stock at Deeping St. James, in Lincolnshire, consequent on feeding with rape-cake believed to have contained mustard. Some newly-purchased rape-cake was given to a herd of cattle in the ordinary proportion of 3 lbs. to 6 lbs. a-piece, according to the size, age, &c., of the beasts. The whole thirty-seven were attacked with symptoms of illness after eating it, and of these, eight died within twelve hours. Samples of the cake were sent to the Royal Veterinary College for analysis. Similar cases have been reported from other quarters. In every instance the cake proved to have been contaminated with mustard. *Veterinarian, Jan.* 1875.

Cork Dust.—BOURGEOIS, of Paris, patents the application of finely pulverized cork, or cork dust, to various purposes, those of the toilette more especially, for which rice and wood powders have hitherto been used. CHEVALLIER fils of Paris also patents the application of the same material to the fabrication of various objects. *Bulletin de la Soc. Chim. de Paris, xxii.* 12.

Substitute for Indian Ink. Dr. AUG. CHEVREUSE has discovered that when the common cockchafer (*Melolontha vulg.*) is decapitated an hour after feeding, each insect yields four or five drops of colouring matter, varying in hue with the leaves that have served as food. Dr. Chevreuse has thus obtained fourteen different tints. M. Nichlés, professor of chemistry, M. Preclaire, professor of design, and M. Chatelain, architect, report that the colour may be used for mechanical and other drawings in place of Indian ink, sepia, &c., and that it is unaffected by exposure to the light, or admixture with water-colours. The fluid is collected on strips of glass or shells. For use it is only necessary to dissolve it in water. Laid on in a thick coat, it serves as a varnish. Two or three insects supply colouring matter sufficient, when suitably diluted with water, for the execution of a small landscape. *Bulletin des Sciences et Arts de Poligny (Jura).*

Improved Varnish for Special Purposes.—MOREAU of Paris patents the following improved varnish :—Infuse 195 grammes of gum sandarach in ¼ litre spirits of wine, also 120 grammes spirits of turpentine in ¾ litre spirits of wine. Stand the two infusions in a water-bath for half an hour; then mix, and place the mixture in the water-bath for fourteen minutes more. Allow it to stand for twenty-four hours, and filter through cotton. The result is a colourless varnish which may be given any desired tint with saffron, Prussian blue, indigo, &c. The patentee states that the effects resemble those formerly produced by the famous "vernis Martin," the secret of which is now lost. *Bulletin de la Soc. Chim. de Paris, xxii.* 12.

Compass Pivots.—DUCHEMIN recommends the substitution of German onyx-agate, which is very cheap, resists the action of acids, and remains bright a long time, for white cornelian and porphyry, which are commonly used in the French navy for the pivots of ships' compasses. *Comptes rendus, lxxix.* 24.

"Body" for Translucent White Ware.—WEISKOPF obtains a highly plastic body, which fires well and yields a white translucent biscuit, thus :—The purest and whitest Norwegian feldspar is pulverized as finely as possible, and mixed with well-tempered Carlsbad clay, which gives the requisite plasticity. If the biscuit is to be smooth and easily fusible, a little bone-dust is added. The subjoined proportions give the best results :—

	Opaque biscuit.	Translucent biscuit.	Opaline biscuit.
Argil . .	1	1	1
Feldspar . .	6	8	8
Bone-dust .	0	0·25	0·6 to 0·7

Organ für die Porzellan- und Thonwaaren-Industrie.

Preservation of Rope.—FILLIETTE patents the following process :—The rope is steeped in a solution of 600 grammes of sulphate of protoxide of copper, 200 grammes of sulphate of protoxide of zinc, and 30 grammes of glycerine evaporated to dryness, the whole mixed with 24 litres of boiling water in a close vessel. *Revue Industrielle, 9th Dec.* 1874.

THE WATCH TRADE OF NEUFCHATEL AND GENEVA.

THE following account of the watch trade of Neufchâtel and Geneva, and of the efforts that have been lately made for its encouragement and improvement, appeared in the "Archives des Sciences Naturelles de Geneve" for the year 1873. We give it as an appropriate sequel to the particulars already published in our pages.

At a meeting of the Société des Sciences Naturelles de Neufchâtel on 9th January, 1873, one of the members, M. Kopp, presented to the society three small maps illustrative of the state of the clock and watch trade within the limits of the canton in 1770, 1820, and 1870. In a notice of the subject subsequently inserted in the society's "Bulletin," the following facts appear :—

In 1770 the manufacture of clocks and watches was followed, as a private handicraft only, at Chaux de Fonds, Sagne, and Ponts. More clocks than watches were then made. There were, however, a few watchmakers resident in the Val de Ruy, at Brevine, and along the shores of the lake. The total number of hands employed in the trade was about 3,000, of whom some 2,550 lived in the mountains.

Fifty years later, in 1820, Chaux de Fonds, Locle, and Fleurier had become important industrial centres ; the other valleys were also possessed of numerous watch factories ; and the total number of hands to whom employment was thus given within the canton was about 4,000, of whom 3,000 were resident in the mountains.

In 1870 the trade had undergone considerable extension, and had become established in the city of Neufchâtel and elsewhere. The number of hands engaged in it within the canton had increased to 13,000, of whom about 5,500 belonged to Chaux de Fonds, 3,000 to Locle, 2,500 to the Val de Travers, and 1,000 to the Val de Ruy, whilst some 500 were resident within the city, and 500 more along the shores of the lake.

The chief depots of the trade were and are Chaux de Fonds, Locle, Fleurier, Neufchâtel, Brenets, and Ponts, where are numerous large marts.

Different localities are noted for different kinds of work. Marine chronometers are made chiefly at Locle, Brenets, and Neufchâtel ; pocket chronometers at Locle, Brenets, Neufchâtel, Ponts, Fleurier, Gorgier, and Chaux de Fonds ; pinions are a specialty of the Val de Ruy ; jewelling, of the lake-shore south of Neufchâtel ; the Val de Travers has extensive manufactories of watchmakers' tools ; Chaux de Fonds does the rose-engine turning ; Sagne, Brevine, and Eplatures are noted for their escapements and finishing ; watch-cases are made chiefly at Chaux de Fonds, Locle, Neufchâtel, and Norogne.

In 1858 an astronomico-horological observatory was established in the canton, from which, since 1860, the time has been telegraphed daily to stations at Chaux de Fonds, Locle, Fleurier, and Ponts.

M. Hirsch has been directed to supply the cantonal authorities with a report on the horological competition, which has been held annually for the last eleven years with increasingly satisfactory results.

The following is a *résumé* of M. Hirsch's report under date 6th January, 1873 :—

The number of chronometers sent in for examination during 1872 was 160 ; in 1871 there were only 145. The mean difference of rates in 1872 was ·52 second, the lowest average yet attained. Locle, which is and always has been the centre of the chronometer trade in the canton, sent 93 ; from Neufchâtel came 29 ; from Brenets, 18 ; Chaux de Fonds and Ponts sent 9 each, and 2 came from Fleurier. Of the whole number, 108 were subjected to a month's trial ; the remaining 52 were tested for a fortnight each only. They were arranged in three classes :—

1. Chronometers in which the mean difference of rate was under a half second. In this class were 85 chronometers with a mean difference of rate of ·35 second.

2. Chronometers in which the mean difference of rate was under one second. In this class were 151, with a mean difference of rate of ·47 second.

3. Chronometers in which the mean difference of rate was over one second but under two seconds. Of these there were 9 only, with a mean of 1·33 second.

In 1862, the first year of the competition, the general mean difference of rate was 1·61 second. It has decreased steadily ever since.

The mean difference of rate of all the chronometers sent in for examination during the eleven years 1861-72, numbering in all 1,059, was ·742 second. Of this number 609 had "anchor" escapements, 303 "lever" escapements, 106 "spring-detent" escapements, and 44 "tourbillon" escapements. Sometimes one form of escapement and sometimes another carried off the highest award. The mean difference of rate of the whole eleven years places the "anchor" escapement highest, but the means of the other patterns for the same period only differ from it by less than the tenth of a second.

The experience of the last four years, regarded separately, indicates a slight difference in favour of *detached* escapements, as the annexed averages render apparent :—

"Tourbillon" escapements,	mean difference of rate,	·515	second.
"Spring-detent"	"	·527	"
"Lever"	"	·550	"
"Anchor"	"	·556	"

It may therefore be asserted that the Neufchâtel makers have carried each pattern of escapement to an equal degree of perfection, so that in each and all the mean difference of rate does not now sensibly exceed a half second. The larger number of the chronometers tested in 1872, *i.e.* 124, had flat springs with Phillips' terminal curves ; some had flat Brequet or double Phillips' springs ; a few had cylindrical, and two only, spherical springs. The difference in the patterns of the springs appeared to exercise no influence over the performance of the chronometers.

Six chronometers with flat springs and double Phillips' curves showed a mean difference of rate of ·67 second when changed from a horizontal to a hanging position ; whilst other forms of spring gave a mean difference of 2 to 2·5 seconds under like circumstances. In 1864 this difference averaged 8·21 seconds. In 1872 the difference of rate produced by change of temperature varied from one-tenth to three-tenths of a second for each degree (Réaumur), giving a mean of ·15 per 1° R. In 1864 the same mean was ·48 second per 1° R. At the competition of 1872 four prizes were awarded, in the following manner :—

The first prize of 125 fr. to M. Ulysse Breting, of Locle, for a pocket-chronometer, with remontoir lever escapement, flat Phillips' spring, no fusee. This chronometer showed a diurnal difference of rate varying from ·17 to ·6 second ; the rate was altered 1·05 second by change from a horizontal to a hanging position ; changes of temperature caused it to *lose* ·13 second for each degree (Réaumur).

The second and third prizes, of 100 fr. and 75 fr. respectively, were carried off by M. Ulysse Nardin, of Locle, with two pocket chronometers with remontoir anchor escapements, Phillips' springs, and without fusees. The diurnal variation of one was ·19 second, of the other ·23 second. The variations of rate arising from changes of temperature were scarcely appreciable. Those induced by change of position gave means of ·23 second and ·47 second respectively.

The fourth prize of 50 fr. was also awarded to M. Ulysse Breting for a pocket-chronometer—an excellent goer despite its complex mechanism, resulting from the introduction of an independent secondary movement. The mean diurnal difference of rate was ·24 second ; that induced by change from a horizontal to a hanging position ·45 second ; that due to changes of temperature, ·09 second for each degree. Like the others, this watch had a flat Phillips' spring.

The development of the Neufchâtel chronometer trade has led the cantonal authorities to increase the number of annual prizes to eight, and to set apart a sum of 800 fr. per annum for pro-

viding the same. The new regulations establishing four classes of chronometers in place of three, took effect from 1st January, 1873. They are as follows:—

1st class. Marine chronometers. To be tested for two months each, at ordinary temperatures, and in the stove. The best to receive a prize of 150 fr., provided the mean diurnal difference of rate is not in excess of ·3 second; that the mean difference of rate for change of temperature does not exceed ·15 second for each degree; that it resumes its normal rate within 1¼ seconds after removal from the stove; and that the difference of rate between the first and last week's performance does not exceed 2 seconds.

2nd class. Pocket chronometers, with anchor or detached escapements. To be tested in five different positions during the space of six weeks each. Three prizes, of 130 fr., 120 fr., and 110 fr., respectively, to be awarded to the three best specimens in this class, provided that their mean normal difference of rate be under a half second; that the difference of rate induced by change of temperature does not exceed ·2 second for each degree; that the difference arising from change of position be under ·3 second; that the watch resumes its ordinary rate of going within 1½ second of its removal from the stove; and that the difference between the mean rates of the first and last weeks of the trial does not exceed 3 seconds.

3rd class. Pocket chronometers. To undergo a month's trial, one fortnight in a horizontal position at ordinary temperature, and the other hanging, and in the stove. The four watches with the smallest differences of daily rate to receive prizes of 100 fr., 80 fr., 60 fr., and 50 fr., respectively, provided they satisfy the subjoined conditions:—the mean difference of daily rate must not exceed one second; the variation with change of temperature must be under ·2 second for each degree; the watch must resume its normal rate within 1½ second after its removal from the stove; the difference of rate arising from changes of position must be under 3 seconds; and the difference between the rates during the first and last weeks of the trial must not exceed 5 seconds.

4th class. Pocket chronometers and watches with compensation balances. To undergo a fortnight's trial only. They will be tested in a horizontal position, and at ordinary temperatures only. No money prizes will be awarded for them; but a written warranty will be returned with each, provided the mean difference in the daily rate of the watch or chronometer is not over 2 seconds.

The Observatory at Neufchâtel receives only chronometers and watches manufactured by residents of the canton. They are to be sent in with a short description appended to each, stating the class in which it is to be tested, and the name of the person who is to regulate it. At the expiration of the prescribed time, the Observatory returns them, with a report of the observed rates during each day of the trial, for which a charge of 20 fr. is made for each watch in the first class, 15 fr. for each in the second, 10 fr. for each in the third, and 5 fr. for each in the fourth class. The makers who take prizes receive a diploma containing a *précis* of the results of the trial of their handiwork.

After recapitulating the foregoing particulars, the reviewer in the "Archives des Sciences Naturelles" observes that the Section of Commerce and Industrial Art of the Geneva Society of Arts has also recognized the utility of the arrangements pursued by the cantonal authorities of Neufchâtel. Since 1871, a similar horological competition has been held annually at Geneva, and with very satisfactory results.

At the Anniversary Meeting of the Society of Arts of Geneva, held on 23rd May, 1873, the Honorary President, General Dufour, handed to MM. Badallet, Patek and Philippe the prizes obtained by them at the previous competition.

The first prize was awarded to M. Badallet, for a pocket chronometer of his make, regulated by M. François Vidonne, with a rectilinear anchor escapement, and a Lutz spring. Its mean difference of rate, determined by Professor Plantamour, at the Geneva Observatory, was only + ·28 second; the difference of rate arising from change of temperature was ·03 second; difference from change of position ·62 second; gained ·57 second after the stove test.

M. Badallet had been crowned the previous year, having exhibited a watch, likewise regulated by M. Vidonne, the diurnal difference of rate in which was + ·38 second. A fusee-chronometer gave a mean of + ·31 second.

The second prize, of 100 francs, was taken by the firm of Patek, Philippe and Co., with a pocket-chronometer having an anchor escapement and Brequet spring. It was regulated by M. C. A. Meylan. Its mean difference of rate was + ·39 second; compensation error, + ·10 second; difference of rate arising from change from a horizontal to a hanging position 1·35 second; ditto after stove test, + ·52 second. The positive sign denotes gain, and the negative, loss of speed.

Two third prizes, of 75 francs each, were also awarded to the same firm.

Early last year Professor Isery communicated to the Société des Sciences of Neufchâtel an interesting essay on horological moments, treating chiefly of the epicycloidal form to be given to wheels and pinions, and accompanied by diagrams and tables.

A pamphlet on the same subject was published at Chaux de Fonds, in 1866, by M. Jacot.

M. Olivier Mathy has made the Neufchâtel Society acquainted with the results of some experiments in painting on enamel and the employment of vitreous glazes, in the hopes of directing local attention to the subject, and thus securing to the canton a share of the decorative branches of horology and jewellery, of which Geneva has heretofore enjoyed an almost exclusive monopoly.

THE ROBEY MINING ENGINE.

IN carrying out some new mining operations near his seat at Trentham, Staffordshire, the Duke of Sutherland has made use of an engine possessing many valuable features, of which we give illustrations to scale. It is designed by Mr. John Richardson, of Messrs. Robey and Co., with a special view to economy of fuel, labour, and space, combined with ease of transport. Nominally it is of 50 horse-power, but can be worked up to 200. In general arrangement this engine resembles a locomotive without wheels. The boiler is over all other parts, being entirely free from extraneous fittings. It is in fact limited to its proper functions as a steam generator, though its weight, with that of its contained water, serves to steady the whole, and to preserve rigidity. The engine is built upon a huge cast-iron base-plate, which is formed at one end into an ashpit with damper doors, and adapted for carrying the firebox end of the boiler. The other end of the base-plate is made into a feedwater heater, above which are the cylinders, whence condensed water and exhaust steam issue, raising the feedwater nearly to boiling point before it is admitted into the boiler. A crutch-shaped casting over the cylinders receives the smokebox end of the boiler, which is securely bolted down, the other end being free to move upon small rollers which support the firebox. The expansion consequent upon getting up steam thus causes no strain upon plates or joints. The huge firebox, which enables slack to be used, combined with the locomotive type of boiler, causes an economy of fuel—in comparison with older types of engines doing the same work—of from 10 to 50 per cent. At present, about a ton of coal is burned in twenty-four hours, with steam at 40 lb., and an indicated horse-power of about 75. The engine parts are fitted up with all modern improvements, the cylinders are steam-jacketed, and the link motion can be used as an effective expansion gear.

The use of the massive base-plate, to which the engine is fixed, is of advantage in enabling the usual heavy and expensive brickwork foundations to be partially dispensed with. One man attends to both driving and stoking, all the levers for working the engine and winding gear being brought together near the firebox, the inner bearing of the drum is upon the base-plate, the outer one being carried upon a heavy balk. A spur-wheel, 8 ft. 4 in. diameter, is bolted on the engine end of the drum, and gears into a pinion, 2 ft. 4 in. diameter, keyed on the crank shaft, both being 9 in. wide on the working faces of the teeth, which are of 4 in. pitch. The drum runs at the rate of about twenty-five revolutions a minute, and the engine nearly four times as fast. The drum has a brake of great power fitted round it, intended to prevent accident in case of either the spur-wheel or pinion giving way; the brake usually employed being one fitted to the fly-wheel.

The principal dimensions are as follows:—Cylinders, each 16 in. diameter by 24 in. stroke. Crank shaft, bent out of one piece of Lowmoor iron, 6¾ in. diameter. Drum shaft, best scrap, 10 in. in diameter. Drum, 9 ft. diameter by 6 ft. wide; cast iron ends, lagged with best English oak. Boiler, 10 ft. 10 in. long by 4 ft. 9 in. diameter. Firebox, 5 ft. 9 in. long by 4 ft. 9 in. wide. Tubes, 74 in number, 3 in. diameter. Working pressure, 100 lb. to the square inch.

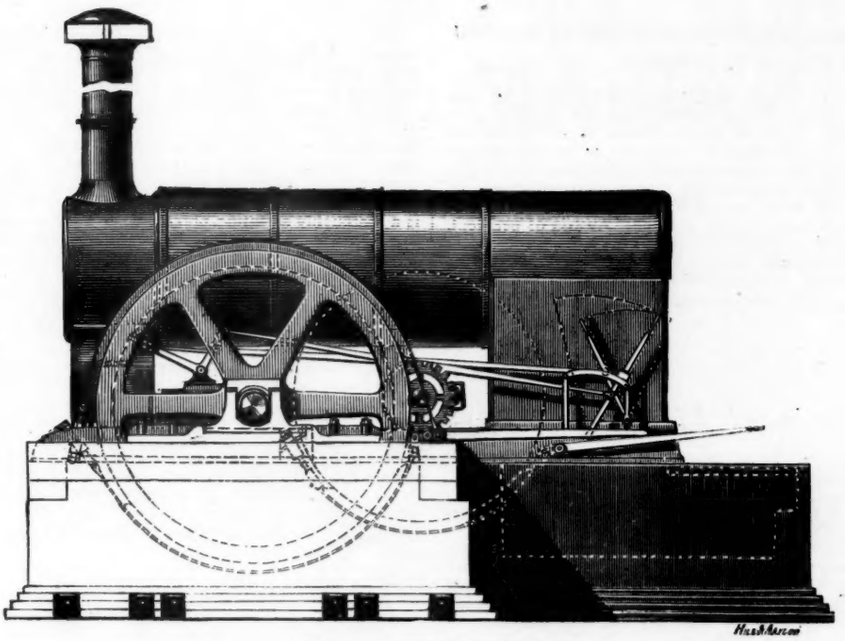


Fig. 1. SIDE ELEVATION.

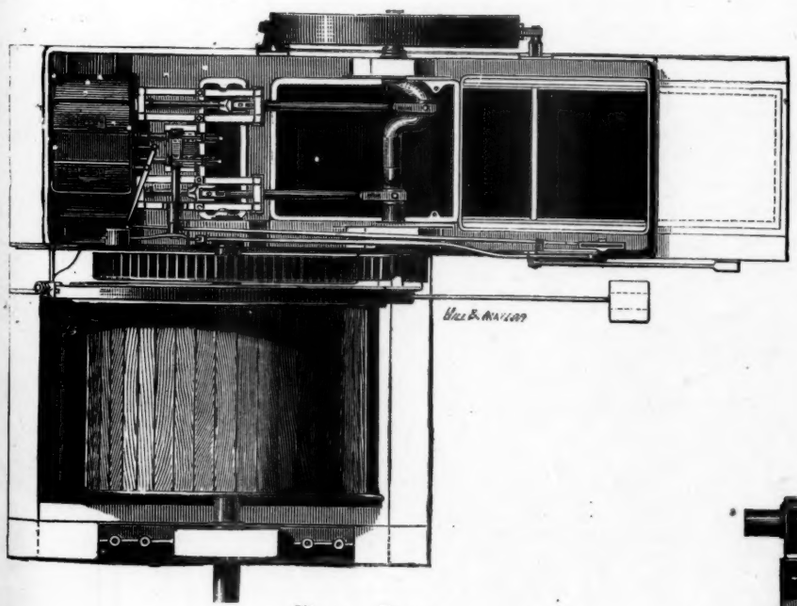


Fig. 3. PLAN.

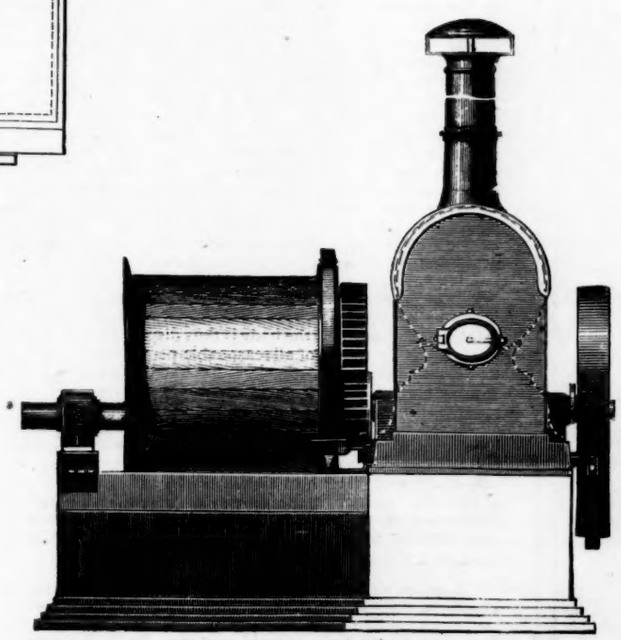


Fig. 2. END ELEVATION.

THE ROBEY MINING ENGINE.

THE CHARACTERISTIC OF SUCCESS IN BRITISH TRADE.

DR. Carl von Scherzer remarks that the products of British industry have attained their great importance in the commerce of the world, not from their superior excellence or variety but from their being generally well adapted to the use of the largest masses of the respective populations. Of the whole business of the port of Smyrna, British imports take up 40 per cent., France 14 per cent., and Austria 9½ per cent. The manufactures of France are less adapted than those of England for populations outside Europe, who do not possess sufficient refinement to appreciate French goods. The latter, however, find a good market amongst the cultivated peoples of South America.

Practical Literature.

CREMATION.[1]

IT is now just a year ago that Sir Henry Thompson's articles on the above subject appeared in the "Contemporary Review," and the interest that was awakened by their publication, as yet appears to show but little sign of abatement. The public press during the last twelve months has been occupied in discussing the question whether it is better to bury than to burn, and we have now before us two contributions to it in volume form, both bearing the date of the present year.

The pamphlet by Sir Henry Thompson consists of the two articles above referred to; the first dealing generally with the question of the treatment of the body after death, the second is a reply to critics—more especially to the objections urged in the "Contemporary Review" by the Medical Inspector of Burials for England and Wales—and an exposition of the process of cremation. Mr. Eassie describes it in language with which we entirely agree, as the only practical work which "has ever appeared in England" on the subject, and remarks that "it will be impossible to understand the full merits of Cremation without perusing it. Its appearance has marked a new era in the history of the question," and "it has awakened an interest which cannot possibly subside."

The little volume by Mr. Eassie, as might be expected, at this later stage of the discussion, deals with the whole question with more minuteness and completeness than Sir Henry Thompson's pamphlet, especially in treating of its practical side. It deals at first with some general matters connected with—and notices briefly the objections which may be urged against—Cremation, and after describing various methods of treating the dead, and showing how widely spread is the practice of Cremation, gives a very concise account of the nature of our burial laws, pointing out in the most unmistakable manner the many evils and dangers which arise from the present system of burial. The last two chapters of his work are occupied with the consideration of the present state of the question and descriptions of ancient and modern Cremation, savage and civilized.

Whatever objections may be urged against Cremation—and there is one very grave objection, viz. the impossibility of detecting the presence of poison after the body is thus disposed of—there can be no doubt in the minds of all reasonable persons, that our present mode of disposing of the dead is an eminently unsatisfactory one. A proposal has, however, been recently put forward by Mr. Seymour Haden, in a letter to the "Times," which deserves consideration before we finally decide in favour of Cremation. He inquires why we do not let the remains of our departed friends return as quickly as possible to earth, and he urges, that within safe limits, early interment should be the rule, and that, instead of the old-fashioned leaden or elm coffin, the simplest possible frame—say of wicker-work, the body resting on fragrant herbs and covered with flowers—should be adopted. Nothing, in short, to prevent or hinder the earth receiving back to itself the dust we commit to it.

The advocates of Cremation will, of course, point out that the evolution of the hurtful gases and vapours, and the overcrowding of cemeteries, will in no way be diminished by this, and they certainly have all the sanitary and practical, if they have none of the sentimental, considerations on their side.

But to return to Mr. Eassie's book, about which, however, we have little more to say than to recommend everyone who wishes to study the subject and to qualify himself to take part in the conversations which are sure to arise upon it wherever two or three people meet, to procure and read it for him or herself. It is a thoroughly scientific, practical, and complete treatise. The illustrations of the English and German patterns of the cremation apparatus, the urns and mortuary chapels, add very considerably to its value.

We have but little space, and less patience, at our disposal to speak of the Rev. H. R. Haweis's "Cremation Prelude." Mr. Haweis is an ultra-broad Churchman, known by two or three volumes of sermons, which have had a considerable sale, who makes a great show of his heresy on every possible occasion. His book is an attempt to advocate Cremation by means of a—love story! We have never read a more ghastly production than this volume. It is a dish of horrors mixed up with a little second-hand science, and garnished with some impossible love scenes and unintelligible rant from a half-mad doctor. The book cannot fail to do harm to the cause it is intended to advocate. What is wanted is the calm statement of scientific facts, not the attempt to gild the subject with a love story, as though it were a pill which the public would not swallow without coaxing.

[1] *Cremation: the Treatment of the Body after Death.* By Sir Henry Thompson, F.R.C.S., M.B., &c. Henry S. King and Co., London.
Cremation of the Dead; its History and Bearings upon Public Health. By William Eassie, C.E., with Illustrations. Smith, Elder and Co., London.
Ashes to Ashes, a Cremation Prelude. By Rev. H. R. Haweis, M.A. Daldy, Isbister and Co., London.

ASTRONOMY.[1]

THIS volume is one of the admirable series of Science Primers published by Messrs. Macmillan and Co., and its aim, as stated by the author, is "first to help the reader by means of simple experiments to form true ideas of the motions of the heavenly bodies, and then to give a sketch of the earth's place in nature, and of the use made of the heavenly bodies for geographical purposes." It is a model of conciseness and comprehensiveness, and sets forth the main facts of the science of astronomy within the compass of less than one hundred and twenty pages, more clearly and fully than is done by many huge volumes that we have perused. The experiments are simple and sufficient, and the illustrations, apparently taken chiefly from the author's other works on this and kindred subjects, excellent. Altogether it is a pattern primer, and ought to be largely adopted in scholastic institutions.

STUMMER'S "INGENIEUR."[2]

IN December, 1873, this excellent weekly was started in Vienna, under the name of "Engineering, German Edition." On January 1 of this year it took an independent place in practical literature, with the above title, and its director, Herr von Stummer, has made it one of the most valuable collections of continental technological science. It is an encouraging sign of the times to find that the "Ingenieur" has already been amply successful, and that there are readers in Germany and Austria for this important addition to the industrial literature of those countries. Glancing at the great extent of periodical practical literature extant in German, one cannot but think that the Germans are one of the most practical of races. We English are beginning—none too soon—to be practical enough to think and theorise, and our literary aids in the task of converting mere handicraft into practical science are not too numerous. Without wishing to make the "Practical Magazine" an English edition of the "Ingenieur," we shall gladly lay before our readers from time to time the most convincing proofs of our esteem for it.

[1] *Astronomy.* By J. Norman Lockyer, F.R.S., &c. With illustrations. London: Macmillan and Co., 1874.
[2] *Stummer's Ingenieur. Internationales Organ für das Gesammtgebiet des technischen Wissens und Repertorium der hervorragendsten ausländischen Fachjournale.* Wien, Fromme. London, Office of "Iron."